SCIENTIFIC AND TECHNICAL SERVICES DIRECTED TOWARD THE DEVELOPMENT OF PLANETARY QUARANTINE MEASURES FOR AUTOMATED SPACECRAFT

FINAL REPORT

Contract NASw-2503

For

National Aeronautics and Space Administration
Planetary Quarantine Office
Washington, D. C. 20546

March 31, 1974

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by

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FOREWORD

This report summarizes the work performed during the second year of scientific and technical support to the Planetary Quarantine Officer under Contract NASw-2503. The reporting period extended from April 1, 1973 to March 31, 1974.

Technical review of the work was performed by Dr. L.B. Hall, NASA Planetary Quarantine Officer, assisted by Mrs. S. Gallagher.

Major contributors to Exotech's work during the contract year were:

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INTRODUCTION

The objective of the effort provided for under contract NASw-2503 was to support the Planetary Quarantine Program of NASA in its research and management functions. This broad objective was more specifically defined to include:

- Support of the Planetary Quarantine research program with systems analysis techniques.
- Providing research integration where needed.
- Maintenance of planetary quarantine operational records.
- Evaluation of operational plans.
- Support of technology transfer between research efforts and flight projects within NASA.
- Supply technical support to the Planetary Quarantine Office.

This report summarizes the work performed under the contract according to the specific tasks set out in the statement of work. The performance was not as task specific as may be inferred by this organization of the report, but rather comprised an integrated operation employing the scientific and technical skills of the project team to:

- Complete the basic knowledge needed to achieve planetary quarantine
- Improve the methods of analysis
- Improve the knowledge and use of the planetary quarantine parameters involved
- Identify potentially contaminating events
- Further the dissemination of new technology to the flight projects, and
- Improve the orderly application of management to the planetary quarantine problem.

The effort throughout the contract period was directed principally toward the advancement of NASA Planetary Quarantine Technology and Management that will be applicable to all future missions to planets of biological interest. Major emphasis has been on the Viking '75 Mission with somewhat less arduous activity to meet the needs posed by Pioneers 10 and 11 and Mariner Venus Mercury '73.

The material in this report is organized in four parts; viz., a section describing the work performed on each of the twelve tasks, a statement of conclusions and recommendations, Appendix A which presents details on three of the analytical studies performed and Appendix B which contains the two Technical Information Memoranda issued during this contract year.

TASK SPECIFICS

Task 1. Evaluation of the Impact of Changes in Planetary Quarantine Requirements

Planetary quarantine requirements and parameters result from standards developed by COSPAR, recommendations made by the Space Science Board (SSB) of the National Academy of Sciences and from specifications generated within NASA. Periodic reassessments of these requirements are undertaken and are motivated by new information concerning the risks and the probability of planetary contamination by terrestrial microorganisms and by advances in the technology of planetary quarantine implementation.

Under this task, evaluations are conducted to support the justification and establishment of these requirements and to estimate their implication upon flight projects.

Work performed during the contract year related principally to the review of the following parameters:

- D values
- $P_s(r)$ for surface burden
- P(g) for Mars and Outer Planets
- P(N) for Saturn missions
- P(st) for surviving space travel

<u>D Values</u> — The effect of preliminary data describing the heat resistance of naturally-occurring microorganisms on sterilization requirements was analyzed and a possible methodology for the assessment of these data was developed. In addition, the need for further research was identified. The results of this assessment were presented by Mr. S. Schalkowsky for members of the AIBS Planetary Quarantine Panel at Denver on July 13, 1973. An earlier analysis of teflon strip experiments with naturally occurring microorganisms by Mr. P. D. Stabekis — discussed in Task 8 — served as a primary input to Mr. Schalkowsky's presentation. Both analyses are included in Appendix A.

<u>$P_s(r)$</u> — The possibility of a change in the value of $P_s(r)$ as a result of the work of Mr. M. Chatigny of NBRL, and others engaged in surface release studies, was reviewed to determine if the current specification — which is recognized to be conservative — can be reduced.

P(g) — Values for the probability of growth are needed for Saturn and other Outer Planets and their satellites to facilitate advanced mission planning. Pertinent PQO-sponsored research, conducted principally by the Jet Propulsion Laboratory, and related space studies by others were reviewed in an effort to develop a range of possible values for this parameter.

Assistance was provided to members of Stanford Research Institute, (SRI), in their review of the evaluation and application of P(g) for Mars. In particular, we provided background and historical material and discussed the evolution of the PQ requirements model during a visit to Exotech by SRI personnel on August 6-7, 1973. We later reviewed the SRI draft report entitled, "A Probabilistic Model of Planetary Contamination: Project Viking," by B.R. Judd and D. Warner North. Discussions and further review of the document were held at a meeting at the Stanford Research Institute on October 25th.

P(N) — A value for P(N), the allowable probability of contamination, for the Saturn leg of the Pioneer 11 mission option was developed using an allocation scheme similar to that employed for Mars, Venus and Jupiter. The recommended value of 1×10^{-4} for Saturn and its satellites has been tentatively approved by the PQO.

P(st) — At the request of the PQO, a review was made of research relating to microbial lethality of space vacuum-temperature based upon data previously presented to the Planetary Quarantine Panel, new data from JPL tests and from pertinent literature. Recommendations, based on this review and analysis were prepared and presented by Mr. R.P. Wolfson to PQP on April 26, 1973 at Cape Kennedy, Florida. Mr. Wolfson's presentation is included in Appendix A. Following a subsequent presentation by Dr. D. Taylor of JPL at the PQP meeting in San Francisco on February 22, 1974, a new specification sheet was issued for this parameter applicable only to the Viking '75 mission.

In addition to the review of the above discussed parameters, a new parameter was introduced. It refers to the minimum number of spores per assay, n_{min}, acceptable in determining the minimum terminal sterilization cycle. The value for this parameter was arrived at using the results of a meeting of the Viking Terminal Sterilization Process, held in Denver on December 11, 1973.

Overall, in the compilation of parameter specifications issued in the PQ Specification Book — an activity addressed in Task 5 — over thirty (30) separate parameters were reviewed for currency and adequacy.

Task 2. Maintain and Operate the Planetary Quarantine Document System

The Quarantine Document System (QDS) is an indexed file of material pertinent to the review of flight project quarantine plans and operations.

This task covers the operation, maintenance and updating of the system. It requires the application of techniques for source identification, acquisition criteria, cataloguing and indexing, and responsive retrieval.

Many retrievals were requested by PQO and ESI staff members in support of such activities as the NASA Life Sciences Committee's review of the Planetary Quarantine Program, the Viking Project Bioassay Program, the preparation of materials for presentation at COSPAR, PQP and at the Spacecraft Sterilization Seminars and of the review of parameter specifications, e.g., Task 1.

Among the retrievals conducted during this contract period, in support of the PQO, are:

- Material relating to agreements made with the VPO regarding Viking bioassays
- COSPAR's position on sample return and back contamination
- Transmittal letters for Post Launch Analysis reports for past missions
- Decisions and policy actions bearing on outer planet quarantine
- Background discussions and actions relating to sample return and back contamination strategies and missions
- Material relating to the review of Viking Program PQ Plan, the VLC Sterilization Plan and the Viking Microbiological Assay Plan
- References to tests of the sensitivity of microorganisms to radiation applied after heat treatment
- Schemes and values used for P_c allocation to flight projects

Additional summarizations in special binders have been provided on:

- PQ Policies, Decisions and Actions for Outer Planet Missions
- Planetary Quarantine Issues Relating to Sample Return Missions

The QDS staff was called on to provide several reference searches for papers and presentations being readied for publication in well known journals, etc. Much of the referenced materials are contained in the rapidly expanding system.

During the contract period the QDS experienced a growth of 379 documents, raising to 904 the total number of documents in the system.

Task 3. Microbial Contamination Logs

The Committee on Space Research (COSPAR) has asked each launching nation to supply it with information on all planetary missions that will permit the maintenance of a contamination log. For purposes of records and the allocation of contamination probabilities to future missions to planets of biological interest, the Planetary Quarantine Officer requires a log of missions of all nations insofar as data are available.

This task supports the preparation and maintenance of these logs. In particular, it requires:

- Maintaining the existing space logs of United States planetary missions for all planets of biological interest.
- Obtaining data from pre and post launch analyses and entering for new missions as they occur.
- Applying extrapolation and estimation techniques to foreign data when exact data are not available.
- Preparing for the Planetary Quarantine Officer a current log of United States missions for presentation to the Planetary Quarantine Panel of COSPAR at their annual meeting.
- Maintaining in the Planetary Quarantine Office a status board of the United States space log updated within two weeks of the time the data become available, supplying copies by photographic or other means within seventy-two (72) hours following request by the Planetary Quarantine Officer.

During this contract year, a log for the planet Jupiter was prepared and the Mars and Venus logs were updated. Copies of these logs were submitted to the PQO for delivery at the annual COSPAR meeting held at Konstanz, FRG in May 1973. The retargeting of Pioneer 11 has been followed closely, since one of the options under consideration was to place the spacecraft in a Saturn fly by trajectory. If this option is chosen, a contamination log will be established for the planet Saturn.

As additional flight data became available from Pioneer 10 and 11 and Mariner 10 the logs were updated. Summarizations were noted on the PQ Status Board. The updated data appear in column 11, 14 and 15 (see Figure 1).

Task 4. Maintenance of Allocation Bank

The United States and the Union of Soviet Socialist Republics plus other launching nations have each been allotted a portion of the total probability of contamination of Mars and with an estimate of the total number of missions that may be flown by each nation. From these data, the Planetary Quarantine Officer makes pre-launch allocations of the probability of contamination that my be used by each nation.

The purpose of this task is to assist the Planetary Quarantine Officer in making the most liberal allocation, consistent with COSPAR policy, to each United States mission. In achieving this goal, data were acquired to maintain, on a current basis, records of the allocation of the probability of contamination to each planetary mission. These data were entered and compiled in columns 17 and 18 of the PQ Status Board (see Figure 2).

Results of the Pioneer 10, 11 and Mariner 10 missions were continuously reviewed for possible effects on the allocation banks for Venus, Jupiter, and possibly, Saturn.

A review of the status of mission suballocations was performed. QDS references summarizing review results are shown in Table 1.

A P(N) value for the Saturn encounter option of the Pioneer 11 mission was developed and recommended for application. Allocation methods for outer planet missions were reviewed.

Task 5. Creation and Maintenance of List of Approved Parameters

Uniformity of policy and facilitation of document review can be effected through a listing of parameters and requirements employed by flight projects in validating compliance with basic PQ constraints. This task covers

FIGURE 1

PLANETARY QUARANTINE STATUS BOARD

PLANET	MISSION	PROBABILITY OF CONTAMINATION		
		INITIAL ALLOCATION	PRELAUNCH ESTIMATE	POSTLAUNCH ESTIMATE
JUPITER	PIONEER 10	6.4×10^{-5}	3.1×10^{-6}	1.7×10^{-10}
	PIONEER 11	6.4×10^{-5}	2.02×10^{-8}	2.3×10^{-10}
VENUS	MARINER 10	7×10^{-5}	2.03×10^{-7}	4.2×10^{-9}

FIGURE 2

PLANETARY QUARANTINE STATUS BOARD

PLANET	MISSION		ALLOCATION BANK		
			BALANCE of P_c	CUMULATIVE BALANCE	
JUPITER	PIONEER 10		6.4×10^{-5}	6.4×10^{-5}	
	PIONEER 11		6.4×10^{-5}	1.28×10^{-4}	
VENUS	MARINER 10		7×10^{-5}	2.3×10^{-4}	

TABLE I.

P(N)-PROBABILITY OF CONTAMINATION ALLOCATION STATUS

PLANET	MISSION	DOCUMENTATION REFERENCE	
MARS	Sub-allocation Schemes for All Martian Missions	PQ-109	(Allocates to 70 landers and 30 non-landers)
		PQ-87	(Allocates to 18 future U.S. flights)
		PQ-369	(Reallocates recoverable allocations)
	Mariner Mars '64		(Governed by NASA-developed specifications)
	Mariner Mars '69		(Governed by specification deriving from COSPAR 26.5)
	Mariner Mars [illegible]	PQ-109	(Recommends to SL an allocation of 30×10^{-6})
		PQ-41	(Authorizes use of 71×10^{-6})
	Viking '75	PQ-109	(Recommends to SL an allocation of 31.4×10^{-6})
		PQ-40	(Authorizes use of 72×10^{-6})
		PQ-561	(Authorizes use of 100×10^{-6})
VENUS	Suballocation Schemes	PQ-53	(Implies a methodology)
	Mariner Venus '62		(no evidence of requirement)
	Mariner Venus '67		(Governed by specification derived from COSPAR 26.5)
	Mariner Venus/Mercury '73	PQ-53	(Authorizes use of 70×10^{-6})
JUPITER	Suballocation Schemes	PQ-71	(Allocates to 35 landers and 15 non-landers)
	Pioneer F and G	PQ-71	(Recommends 64×10^{-6} for F and G)
		PQ-49	(Authorizes 64×10^{-6})

the preparation of such a listing with definitions, references to pertinent research, and approved numerical values or ranges.

The major development under this task has been the design, preparation and issuance of the PQ Specification Book, referred to in this report in Task 1. After the review and assessment of over 30 separate parameters a document was prepared containing specification sheets for each parameter approved by the PQO for use or for planning purposes by unmanned planetary space programs. This document was issued under NASA cognizance to appropriate NASA Centers, flight projects and active contractor personnel. Appropriate provisions are in effect to maintain the PQ Specification Book in up-to-date condition to ensure that it accurately reflects the current regulations and standards issued by the PQO.

The document and its intended utilization were described by E.J. Bacon at the AIBS Spacecraft Sterilization Seminar in Denver on July 11, 1973.

Task 6. Preparation of Technical Information Memo

The Planetary Quarantine Technical Information Memo (TIM) is a brief, informal newsletter containing summaries of research results of note, meetings, significant travel plans, policy decisions, changes in personnel, initiation of new research tasks, and management deadlines.

The issuance of TIMs was discontinued in the course of this contract period, per the direction of the PQO. As a result, only two editions were issued:

7/6/73 – Listed planned presentations at COSPAR, Konstanz, FRG; reported on Stockholm symposium on automated biology methods; and discussed change in KSC-USPHS lab support.

8/23/73 – Reported on status of KSC-teflon tests, on LSC Viking Meetings at TRW, and on the new JPL role in directing the KSC-assay lab operations.

Copies of the above two TIMs are contained in Appendix B.

Task 7. Evaluation of Flight Project Quarantine Plans

This task provides support to the PQO in the review and approval of flight project documentation and in the exercising of his surveillance responsibilities for assuring flight project compliance with PQ requirements.

During the contract year, the following documents were reviewed:

1. Pioneer 11 Post Launch Analysis Report
2. Pioneer 11 Pre-Maneuver Analysis of Probability of Contamination to the Planet Jupiter
3. Pioneer 11 Pre-Maneuver Analysis of Probability of Contamination to the Planet Saturn
4. MVM '73 Pre-Launch Analysis Report
5. MVM '73 (Mariner 10) Post-Launch Analysis Report
6. MJS '77 Planetary Quarantine Plan
7. Viking '75 Program Planetary Quarantine Plan (Preliminary, revised and final copies)
8. Viking '75 Program Lander Capsule Sterilization Plan (Preliminary, revised and final copies)
9. Viking '75 Program Microbiological Assay and Monitoring Plan (Preliminary, revised and final copies)

The Pioneer 11 Post Launch Analysis report was approved and transmitted August 7, 1973 to the SSB for referral to COSPAR.

The Pioneer Project was requested by the PQO to supplement its Post-Launch Analysis to include the effects of the proposed option to encounter the planet Saturn. To assist in this analysis, the PQO issued tentative working values for P(g) for Saturn and its satellites and for an allocation of P_c for this leg of the mission. The further analysis of this option was discussed during a meeting at ARC on August 23, 1973 attended by the PQO, members of the Pioneer Project and Exotech. Two pre-maneuver analysis reports were subsequently issued for the probability of contamination to the planets Jupiter and Saturn. Both reports were reviewed, were found satisfactory and were recommended to the PQO for approval.

The MVM '73 Pre-Launch Analysis was approved and the mission was certified for launch. The subsequent post-launch analysis report was also approved and a transmittal letter to SSB was prepared for referral to COSPAR.

The MJS '77 Planetary Quarantine Plan was approved.

The preliminary drafts of the three Viking '75 plans were reviewed in a meeting held in Washington, D. C. on September 25–26, 1973. Meeting attendees were:

Professor R. Bond, Chairman	AIBS, PQP
Dr. L.B. Hall	PQO
Mr. L. Daspit (Viking Project)	NASA/Langley
Dr. J.A. Stern	Bionetics Corp.
Mr. M.J. Landry	Bionetics Corp.
Mr. S. Schalkowsky	Exotech
Mr. R.P. Wolfson	Exotech

Working agreements were reached on all items discussed. The plans were then revised by the project accordingly and were reviewed by our staff in detail.

In connection with our review of the Viking '75 PQ Plans and lower level PQ documents, working sessions have commenced in Langley, Virginia during which review and discussion of drafts of all pertinent models were initiated. These models included the Bio-Burden Model, the Sterilization Model and the PQ model. In addition to the plans and models, draft revisions of other documents relating to pertinent analyses were received and reviewed.

As a result of our working se ·ons at Langley, Virginia, and the several documents received and reviewed, a wo ing PQ milestone schedule was issued with a copy submitted to the PQO. This working review activity of the Viking Models, reports, and analyses will be a continuing major effort during the coming contract year.

A list of Flight Project PQ-related meetings attended during this contract year is given in Task 10 of this report.

Task 8. Supporting Analysis of Planetary Quarantine Sterilization Parameters

This task includes analyses and evaluations intended to support the interpretation of research results and to facilitate the quantification of PQ requirements.

During the contract year, several assignments were carried out under this task.

At the request of the PQO, an analytical review of data from teflon-strip experiments with naturally occurring organisms was undertaken in order to identify the heat resistance of the "hardy" subpopulation and the fraction of that subpopulation to the total spore populc[illegible] results of this analysis were presented by Mr. P.D. Stabekis to the PQP at Cape Kennedy, Florida on April 26, 1973 and at the AIBS Spacecraft Sterilization Seminar at Denver on July 11, 1973. Mr. Stabekis' presentation is included in Appendix A.

Subsequent to this analysis, a review of the impact of the results of the heat inactivation tests of naturally occurring organisms on sterilization requirements was undertaken. This study, referred to in Task 1, was presented by Mr. S. Schalkowsky to the AIBS PQP at Denver on July 13, 1973.

Another effort under this task was the review of data on lethal effects of space UV and the modification of the specification sheet for the probability of surviving UV by applying a correction factor to account for the change in UV flux with distance from the Sun.

Data relating to potential inactivation due to solar radiation and exposure to trapped belt radiation were reviewed with particular reference to the value of space survival parameters for Martian and Outer Planet missions. The possibilities of exposure to high intensity fluxes with sufficient energy and duration for effective reduction of surface burden were investigated. A major portion of the applicable experimental data was the work performed by the JPL.

At the request of the PQO, a preliminary analysis was performed of the probability of contamination of the Viking Biology Instrument (VBI) both directly from viable microorganisms on the instrument's surfaces after sterilization and indirectly from viable microorganisms released from the Viking Lander's surfaces, deposited onto the VBI's primary sample field, picked up by the sample scoop and transferred to the interior of the VBI. This analysis was performed using R. Puleo's "hardy organism" fraction.

Currently, preliminary consideration is being given to a Mars Surface Sample Return (MSSR) mission by the NASA. Our effort has been devoted during the contract period to reviewing the current studies, mission options, and scientific questions relevant to this activity. Preliminary identification has been made of the risk elements and analysis tasks necessary for such return missions. Effort will continue to review on-going activities and to identify the basic possible risk analysis approaches which might be applicable to this type sample return missions.

Task 9. Preparation of Technical Presentations

This task relates to the preparation of written and graphic material as required by the PQO for publications, briefings, speeches on PQ subjects and communications to individuals and groups.

During the contract period the following support was provided under this task:

- Written, visual and taped material documenting the PQ presentation of January 23, 1973 to an Ad Hoc Subcommittee of the Life Sciences Committed. [This activity is partially complete.]

- Visual materials prepared for presentation to the PQP April 1973 at the Kennedy Space Center.

- Final preparation of the presentation of the COSPAR meeting at Konstanz, FRG., May 1973.

- Preparation and reproduction of Contamination Logs for Mars, Venus and Jupiter for delivery at COSPAR.

- Preparation and reproduction of Specification Sheets for U.S. Planetary Quarantine Program for distribution to COSPAR attendees. [Unofficial document prepared specially for COSPAR]

- Support to the PQO in preparation of a paper on control aspects of PQ for publication in a future issue of Critical Reviews in Environmental Control produced by the Chemical Rubber Company.

- Microbial Viability Under Exposure to the Simulated Space Travel Stresses of Temperature, Time and Vacuum, presented by R.P. Wolfson to the AIBS PQ Panel, Cape Kennedy, April 26, 1973.

- Preliminary Analysis of Early Teflon Strip Experimental Data on Naturally Occurring Organisms, presented by P.D. Stabekis to the AIBS PQ Panel, Cape Kennedy, April 26, 1973.

- Visual material on quarantine concerns in sample return missions for presentation to the Administrator, Office of Space Science in September 1973.

- Methodology for Analyzing Heat Inactivation Testing of Naturally Occurring Organisms, presented by P.D. Stabekis to AIBS Spacecraft and Sterilization Seminar, Denver, July 11, 1973.

- PQ Parameter Evaluation Control and Information Dissemination, presented by E.J. Bacon to the AIBS Spacecraft Sterilization Seminar, Denver, July 11, 1973.

- Implications of New Information on Sterilization Requirements, presented by S. Schalkowsky to the AIBS PQ Panel, Denver, July 13, 1973.

- Summarization of technical data in graphical form for the PQO to support his presentation at the meeting on MSSR held at the NASA/Ames Research Center on October 24-25, 1973.

- "Foundations of Space Biology and Medicine," Chapter 4. "Planetary Quarantine Principles, Practices and Problems." Final copy submitted to Dr. White.

Task 10. Technical Support at Meetings

The PQO has frequent need for technical support relative to meetings of the LSC, SSB, COSPAR, flight project PQ reviews and working groups and experimenters' conferences. This task covers the provision of this support on request of the PQO and includes the compilation of analytical data, attendance at specified meetings and presentations as requested.

Such support was provided for the following meetings and conferences:

1973 –	April 19-20	JPL/Exotech Meeting re P(st) and JPL Experimental Data –	Pasadena, Calif.
	April 26-27	Planetary Quarantine Panel	Cape Kennedy, Fla.
	May 19	PQO/VPO/Bionetics/Exotech — Viking Discussions	NASA/Headquarters
	May 29	Bionetics/Exotech — Viking PQ Review	Hampton, Virginia
	May 30-31	Wild Organism Experimental Data	Cape Kennedy, Fla.
	June 1	Wild Organism Experimental Data (con't.)	Cape Kennedy, Fla.
	June 28	PQO/Langley/Bionetics/Exotech — Viking PQ Review Meeting	Hampton, Virginia

	July 11-12	AIBS Spacecraft Sterilization Seminar	Denver, Colorado
	July 12-13	AIBS Planetary Quarantine Panel	Denver, Colorado
	Aug. 15	Viking Biology Instrumentation Meeting	Hampton, Virginia
	Aug. 21	Viking Biology Instrumentation Meeting	TRW - Los Angeles
	Aug. 22	Back Contamination Meeting	JPL - Pasadena
	Aug. 23	Pioneer 10 and 11	NASA/Ames, Calif.
	Sept. 18-20	Viking Lander Critical Design Review	Denver, Colorado
	Sept. 25-26	Viking PQ Plans - Review Meeting	Washington, D.C.
	Oct. 4-5	Viking PQ Review Meeting	Hampton, Virginia
	Oct. 24-25	Mars Surface Sample Return Symposium	NASA/Ames, Calif.
	Oct. 25	Viking PQ Analysis Meeting	SRI, Calif.
	Nov. 1-2	AIBS Planetary Quarantine Panel	Cape Kennedy, Fla.
	Dec. 19-20	Viking PQ Review Meeting	Hampton, Virginia
1974 –	Jan. 10	Pioneer 11 Retargeting Meeting	NASA/Headquarters
	Feb. 19	Viking PQ Related Meeting	NASA/Ames, Calif.
	Feb. 20	Pioneer 11 PQ Review Meeting	San Francisco, Calif.
	Feb. 20-21	AIBS Spacecraft Sterilization Seminar	San Francisco, Calif.
	Feb. 22	AIBS Planetary Quarantine Panel	San Francisco, Calif.
	Feb. 25-26	Viking Review - PTC Sterilization	Denver, Colorado
	Mar. 14	Viking PQ Review	NASA/Headquarters
	Mar. 20	Viking Orbiter PQ Review	JPL - Pasadena
	Mar. 20-21	NHB 8020.12 Revision Meeting	JPL - Pasadena

Task 11. Support of Technology Transfer

This task supports the transfer of PQ technology between Centers, between Centers and Projects, between NASA and its contractors and between NASA and the scientific community. It covers such activities as the preparation of technical presentations and technical support at meetings (subjects of Task 9 and 10), as well as the dissemination of PQ technology information upon referral of inquiries by the PQO and the preparation of material for the AIBS PQ Panel.

Requests for PQ information have been received from PQO staff and the GWUBSCP and have been filled by retrievals from the QDS. In addition, assistance was provided in suggesting items for consideration at the PQP meeting scheduled for July 12 and 13 in Denver.

Task 12. Integrated Resumes of NASA Research

This task is intended to provide resumes of research combining all relevant data from all sources on a specific subject.

No specific assignments have been made under this task during this contract period; however, several important research areas have been reviewed and pertinent data compiled or reported verbally. These areas include:

- Back contamination and sample return, and
- PQ needs for outer planet missions.

CONCLUSIONS AND RECOMMENDATIONS

The accomplishments of the past year are typified by the development and publication of a full set of updated Planetary Quarantine Parameter Specifications for use in unmanned scientific missions to the planets. The results of experimental and analytical tasks undertaken in support of the program throughout more than eleven years have been gleaned to obtain the level of definition needed at this critical time of implementation in the Viking Project which will place the first U.S. lander capsule on Mars. The emphasis in the tasks performed under this contract has been on coordinated evaluation, analysis, documentation and presentation of PQ requirements to enhance effective implementation in flight projects. Focus has been on active flight projects particularly Viking and Pioneer, however, prospects for missions to the outer planets and a return flight from the surface of Mars have drawn significant attention.

The Viking Project has now progressed into the advanced stages of preparation for transfer to the launch site. Over the next eighteen months or more, the Planetary Quarantine operations in support of the Viking Mission will steadily intensify with the frequency of events that must be observed, evaluated with respect to PQ requirements, and approved step-by-step to insure validity of PQ measures and certification. Scheduling of the operations will be critical and must be closely coordinated with Viking schedules and sensitive to real time developments within the project.

Concurrent effort should be afforded the research and planning tasks requisite for missions to the outer planets and for the return to Earth of samples of planetary surfaces. Appropriate tasks should be defined and initiated to provide for analyses of PQ-related risks in such missions, definition of the measures required for adequate safeguards, identification of experimental research needed to provide basic data for parameter evaluation and the development of PQ operations plans for such missions.

APPENDIX A

- P (st) Analysis
- Analytical Review of Data from Early Teflon Strip Experiments
- Implications of New Information on Sterilization Requirements

P (st) ANALYSIS

Presentation

to

P Q A P

Cape Kennedy, Florida

April 26, 1973

Exotech Systems, Inc.

Robert P. Wolfson

P (st) Analysis

Summary

At the request of the PQO, a review was made of:

1) the previous data and presentations which had been made to PQP;

2) the current JPL Vacuum-Temperature Data being prepared by Dr. D. Taylor; and

3) pertinent literature bearing on P(st).

Recommendations, based on the above review and analysis were prepared and presented to PQP on April 26, 1973 at Cape Kennedy, Florida.

Previous P (st) Presentations

The first PQP presentation reviewed was that presented by Dr. J. Stern of Bionetics Corp. during October 1972 at the Atlanta PQP meeting. This presentation reviewed most of the applicable literature. Figure 3.1-1 is typical of the data presented concerning survival of vegetative organisms. Data also was presented on survival of spores under various temperature and time environments. After reviewing the material presented by Dr. Stern it was apparent that the wide spread of data was due, in part, to the fact that the work reviewed included at least three major variables: organism type; test temperature; and, exposure time. Hence, a clear picture of the effects of vacuum and temperature on organism survival really required a matrix of experimental data as illustrated in Figure 3.1-2.

The next prior presentation reviewed was the JPL presentation at New Orleans on January 30 — February 1, 1973 by Dr. Taylor. The data presented is typified by Figures 3.1-3; 3.1-4; 3.1-5; and, 3.1-6. The data in Figures 3.1-5 and 3.1-6, although not so labeled, was only on the spore forming isolates. Study of the JPL presentation indicated: 1) the data was preliminary and had not been reduced; 2) the JPL experiment was very complete and included all elements of the matrix shown in Figure 3.1-2; and, 3) the data could be presented in a three dimensional format for the two variables of time and temperature, as illustrated in Figure 3.1-7.

Coordination with JPL

Review and discussions were held with Dr. D. Taylor to obtain the final reduced data from JPL's computer analysis of these vacuum-temperature data. This data was subsequently presented at the April 26, 1973 PQP presentation at Cape Kennedy by Dr. Taylor.

Literature Review and PQP Presentation of a Proposed P (st)

The appropriate literature was reviewed on the survival of organisms after exposure to various high vacuum-temperature exposures. Figures 3.1-8 and 3.1-9 show two examples of the type of data in the literature. In general, there was a wide range of: 1) organisms; 2) temperatures; 3) exposure times; and, 4) vacuum levels. Hence, exact comparisons were difficult. Figures 3.1-10 and 3.1-11 show plots of all relevant data for spores and vegetative organisms compared to Dr. D. Taylor's data.

Based on all the data reviewed certain general ground rules were stated (Figure 3.1-12) and using these ground rules, and the data presented by Dr. Taylor on April 26, 1973, a proposed approach to a P (st) parameter was prepared and presented to PQP for their consideration (see Figure 3.1-13).

Figure 3.1-1

EFFECT OF TEMPERATURE ON RECOVERY OF VEGETATIVE ORGANISMS

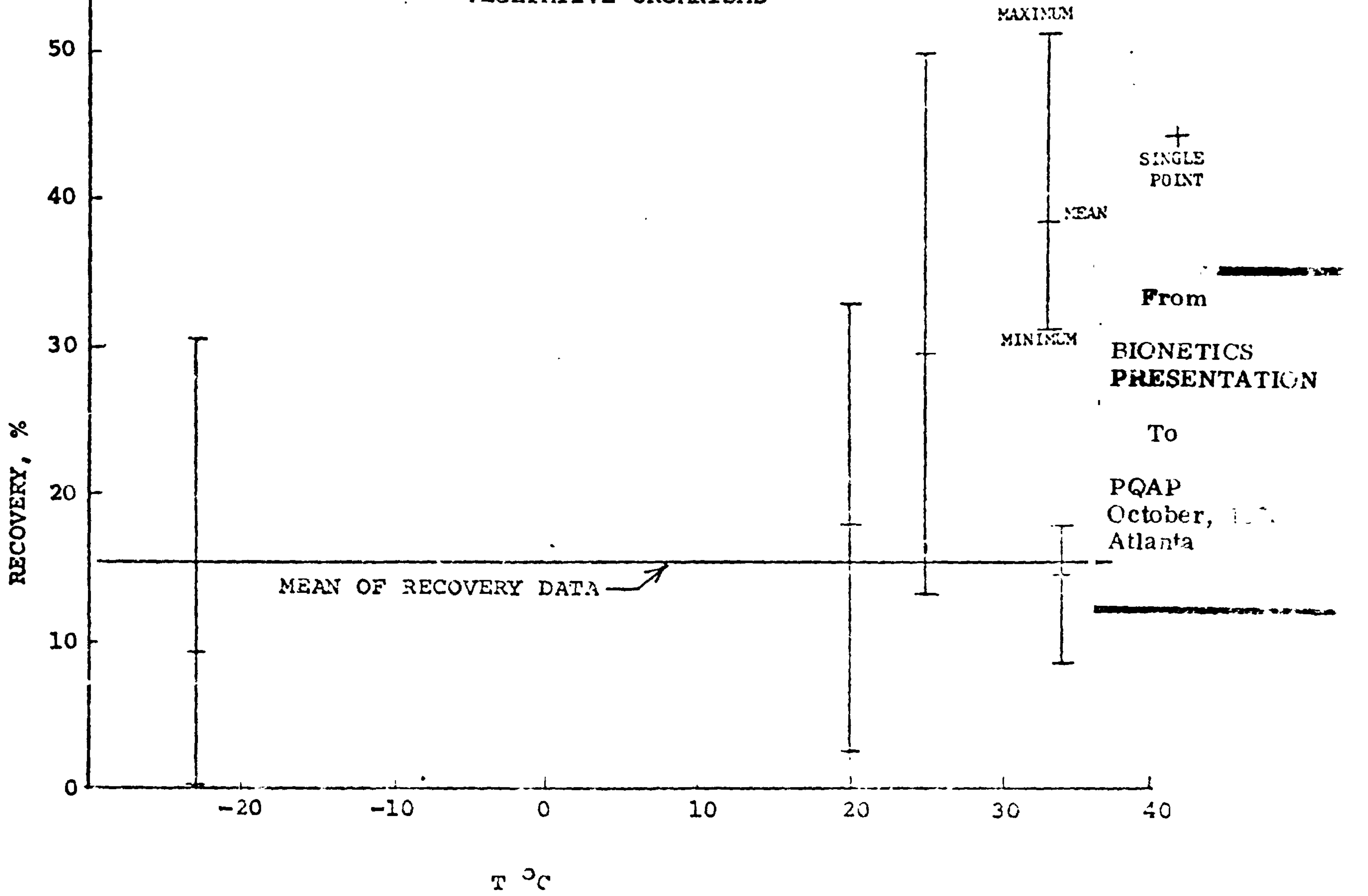


Figure 3.1-2

THE PROBLEM

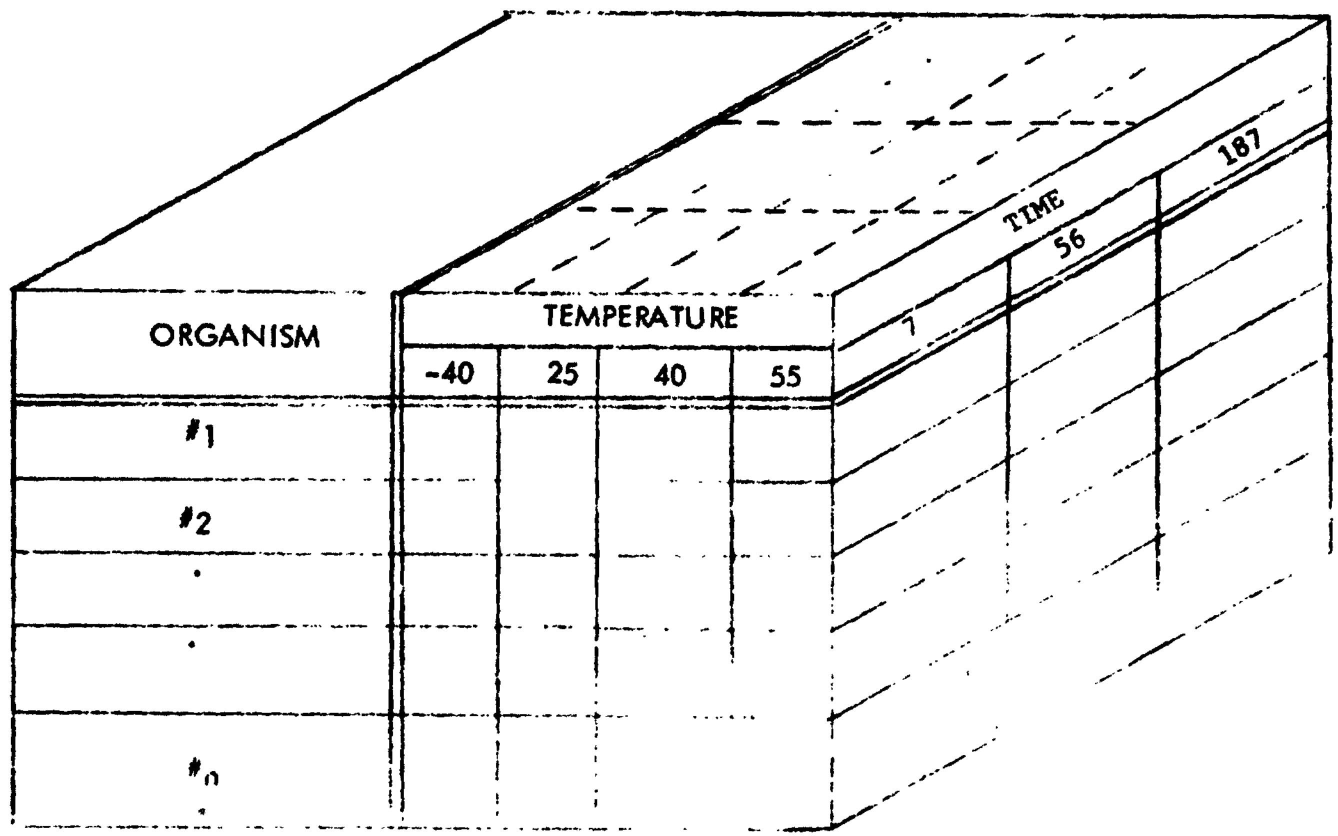
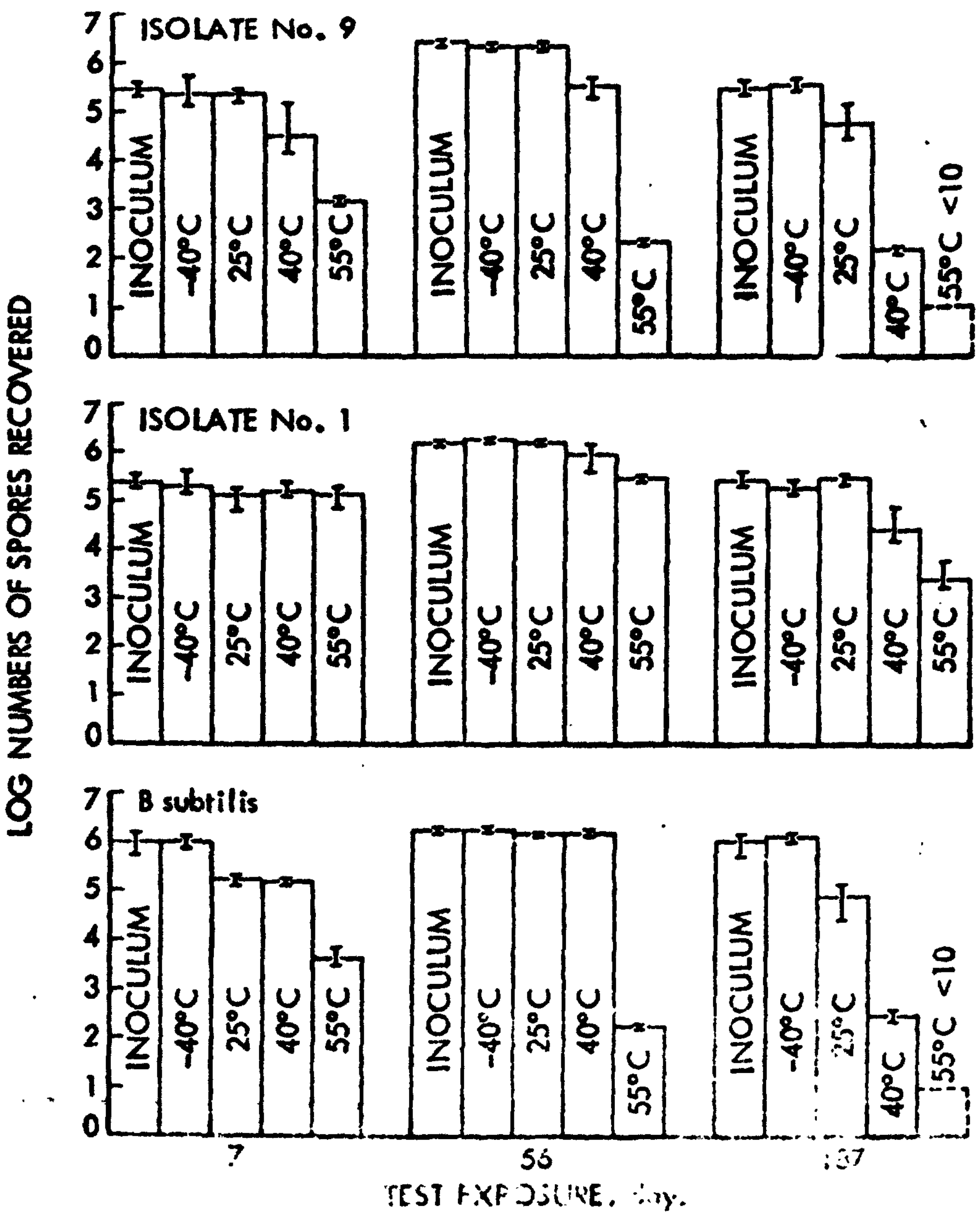


Figure 3.1-3

VACUUM TEMPERATURE RESISTANCE OF SPORES OF SPACECRAFT ISOLATES



New Orleans Semin
January 30/31 197

Figure 3.1-4

DISPERSION VALUES $\left(\frac{\sigma}{\bar{Y}}\right)$

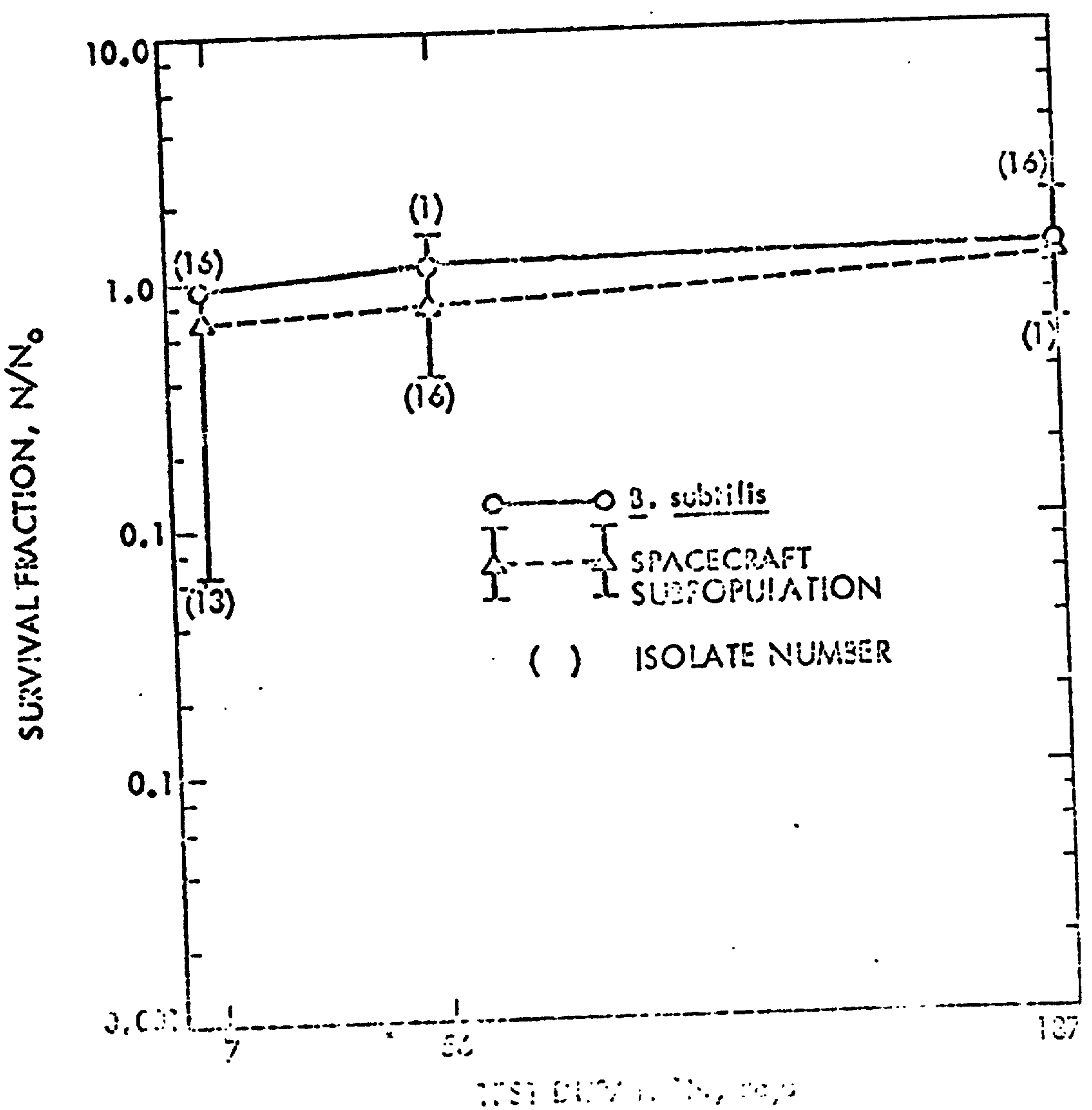
Nonsporeformers

TEMP \ DAYS		7	56	187
No. 4	-40	0.1709	0.0474	0.0100
	+25	0.0582	0.0849	0.0732
	+40	0.1603	0.1731	0.1980
	+55	0.0180	0.3033	0.0962
	t_o	0.1591	0.0768	0.0493
No. 5	-40	0.1272	0.1416	0.0209
	+25	0.0791	0.0513	0.1803
	+40	0.3136	0.0370	0.0632
	+55	0.2304	0.0918	0.0176
	t_o	0.1434	0.0196	0.0040
SE	-40	0.1540	0.0776	0.0801
	+25	0.3277	0.2601	0.0184
	+40	0.1830	0.1652	[illegible]
	+55	0.1037	0.0403	0.0471
	t_o	0.0570	0.0350	0.0415

PQAP
New Orleans
Feb.1,1973

Figure 3.1-5

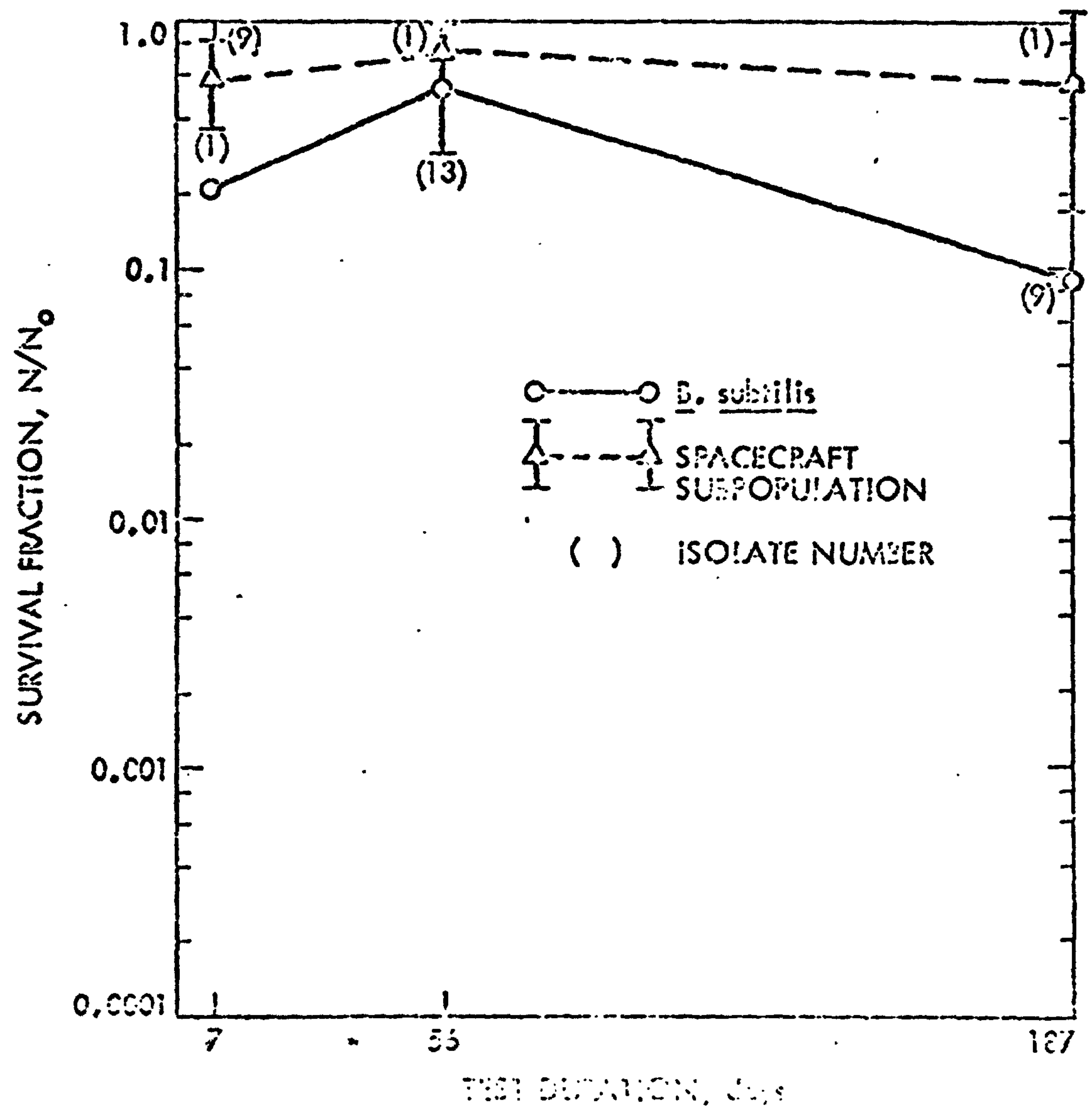
EFFECT OF VACUUM AND TEMPERATURE (-40°C) ON SPACECRAFT ISOLATES



PQAP
New Orleans
Feb.1,1973

Figure 3.1-6

EFFECT OF VACUUM AND TEMPERATURE (25°C) ON SPACECRAFT ISOLATES



PQAP
New Orleans
Feb.1,1973

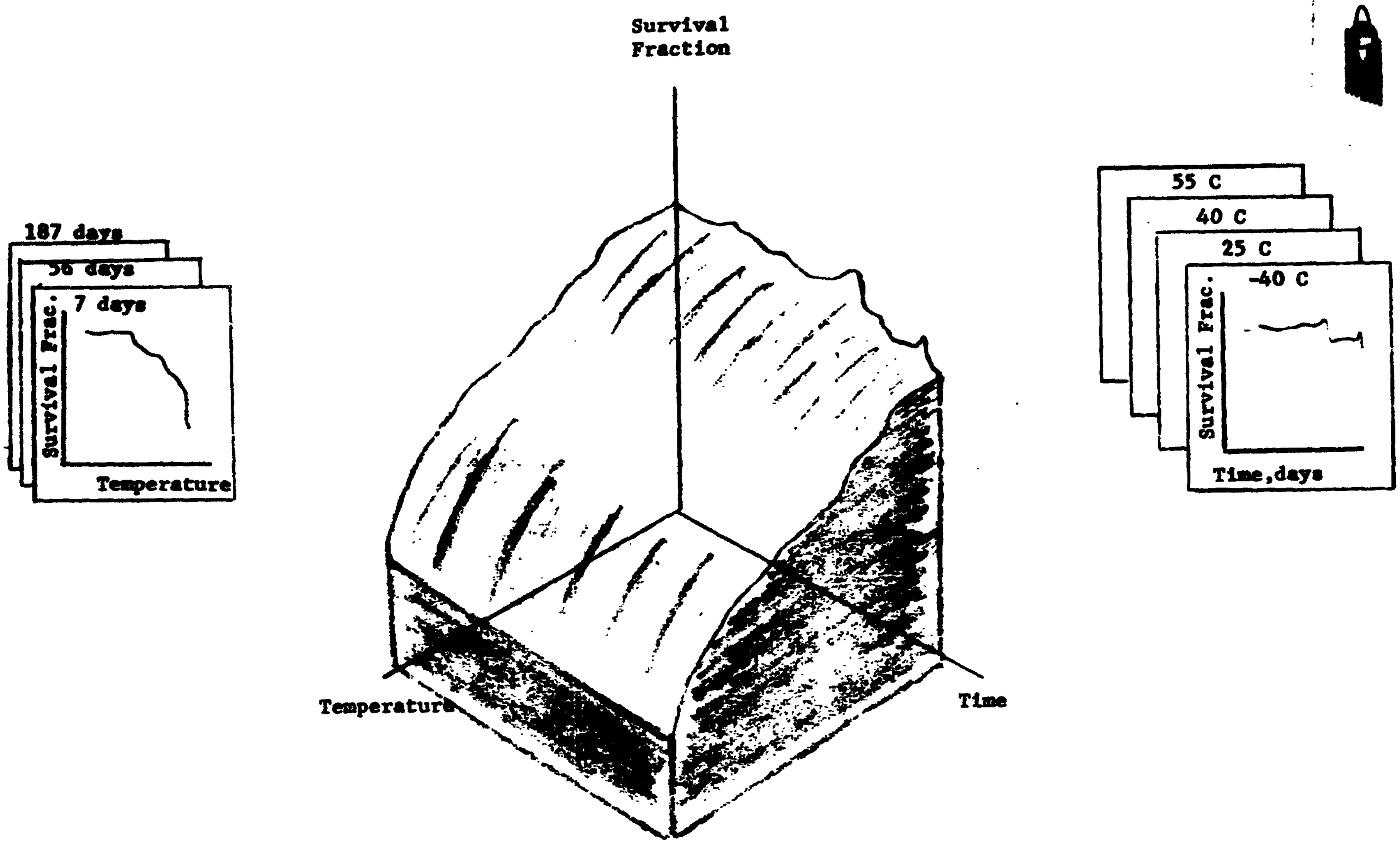


Figure 3.1-7

METHODS OF DATA PRESENTATION

P.I. Imshenetsky

Ref. No. 581

Organism: [ ] Spore [X] Vegetative Name see below

Temperature -23^oC

Duration 3 days

Surviving Fraction see below

Vacuum 10^{-9} mm Hg

Name	Surviving Fraction
Sarcina flava	.305
Mycobacterium rubrum	.302
Pseudomonas pyocyanea	.0034
Escherichia coli	.047
Pseudomonas fluorescens	0
Serratia marcescens	0
Vibrio metchnikouii	0

Figure 3.1-8

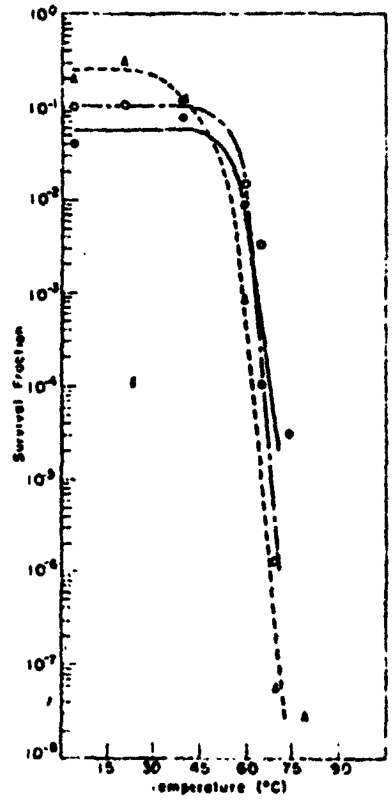


FIG. 2. *Survival of vegetative cells in ultrahigh vacuum (5 days) at various temperatures. Staphylococcus aureus,* ●; *Streptococcus faecalis,* ○; *and strain 248,* ▲. *Survival fraction equals the ratio of surviving cells over the original cell population after 5 days of storage over silica gel (25 C).*

Figure 3.1-9

Silverman & Beecher, 1966

Figure 3.1-[illegible]

DATA COMPARISON--SPORES, SHORT TIMES

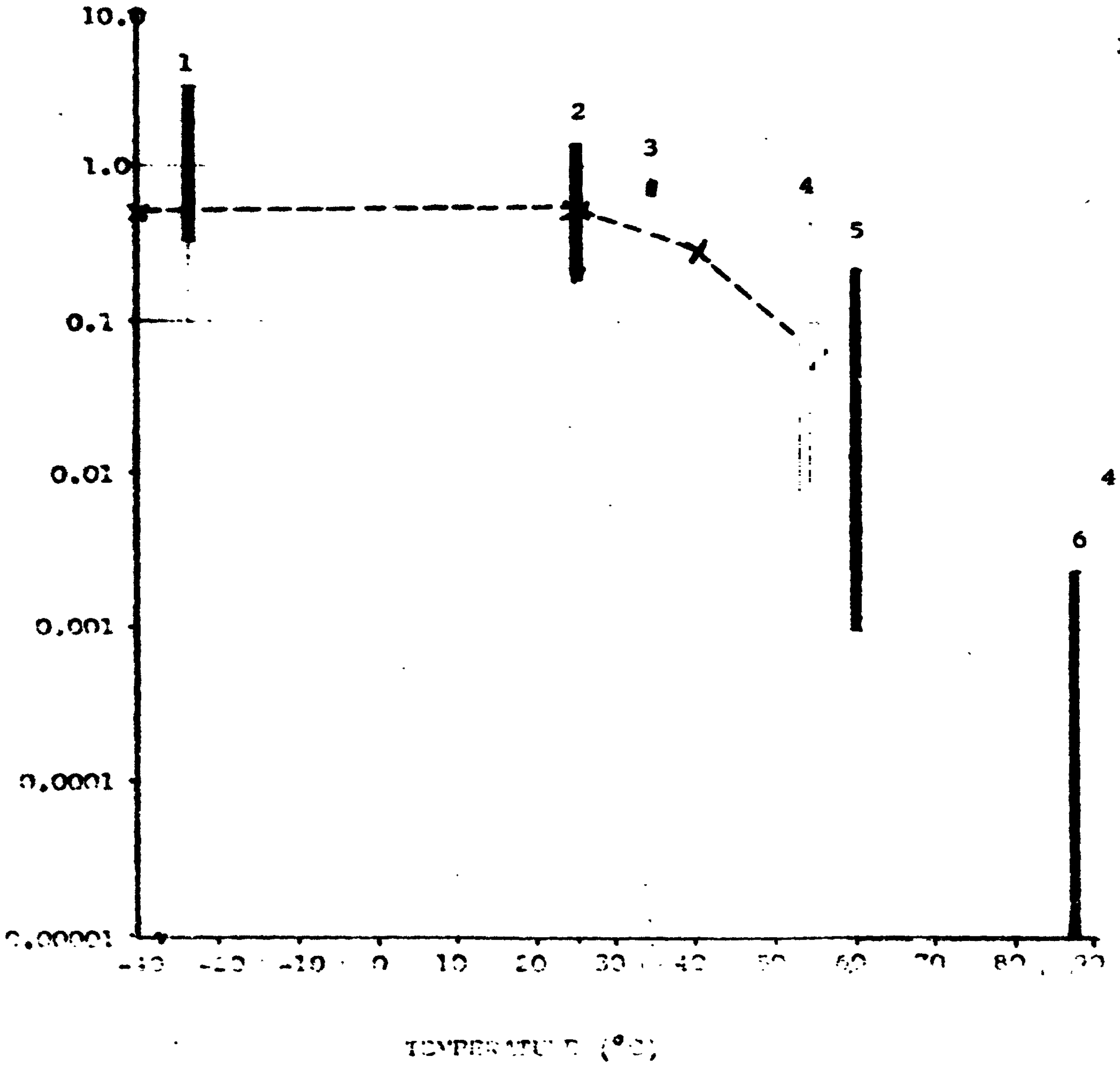


Figure [illegible]

DATA COMPARISON--VEGETATIVE, SHORT TIMES

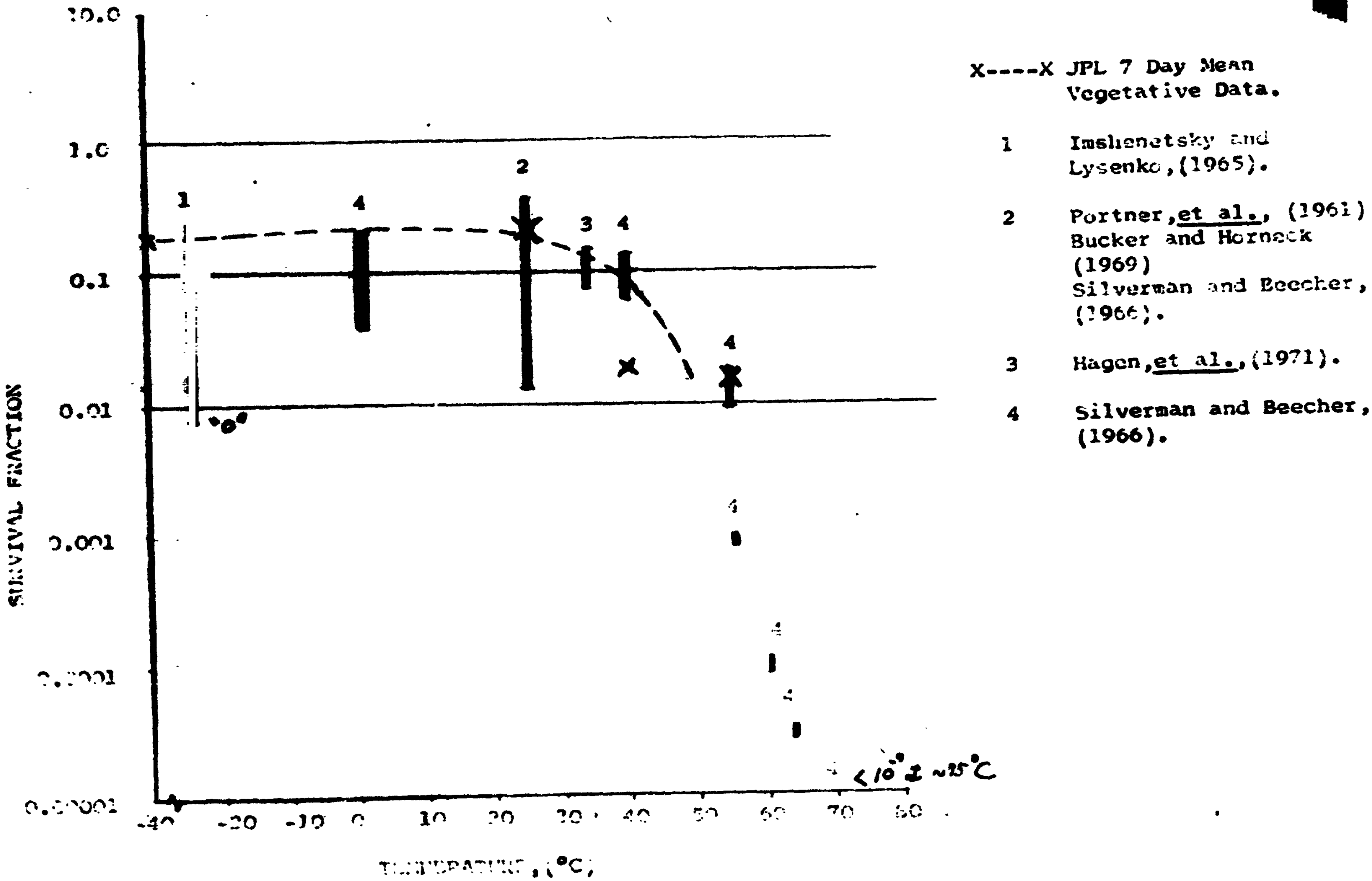


Figure 3.1-12

Recapitulation & Approach to P(st) Definition

- Microbial Survival in space is definite function of Time & Temperature.
- Functional relationship reasonably well defined over certain regions.
- Approach to P(st) definition:
  - should utilize experimental data.
  - should not require new bioassay procedures.
  - should be conservative in poorly defined time/temperature regions.

P(st)

PARAMETER TITLE: Probability of Surviving Space Travel

VALUE	
UPPER	1.0
ACCEPTABLE	See Curves Page 2
LOWER	.01

APPLICATION	
MISSION	ALL
PLANET	ALL

PARAMETER DEFINITION: The probability that a microorganism, exposed to the vacuum-temperature conditions of interplanetary space travel, will survive.

APPLICABLE SOURCE: Surface microbial populations, both spores and vegetative, which have not been exposed to heat sterilization or radiation decontamination.

CONSTRAINTS:

P(st) = 1.0 for any times less than 28 days

P(st) = 1.0 for any temperature less than 25°C

P(st) = value from curves shown on page 2

P(st) = 187 day value for longer exposure times, see page 2

Values may be extrapolated in the unshaded regions of page 2.

REFERENCES: Discussions of Recommendations Regarding Value of P(st). AIBS PQAP Meeting, Cape Kennedy, Florida, April 26-27, 1973.

Planetary Quarantine Officer

Date

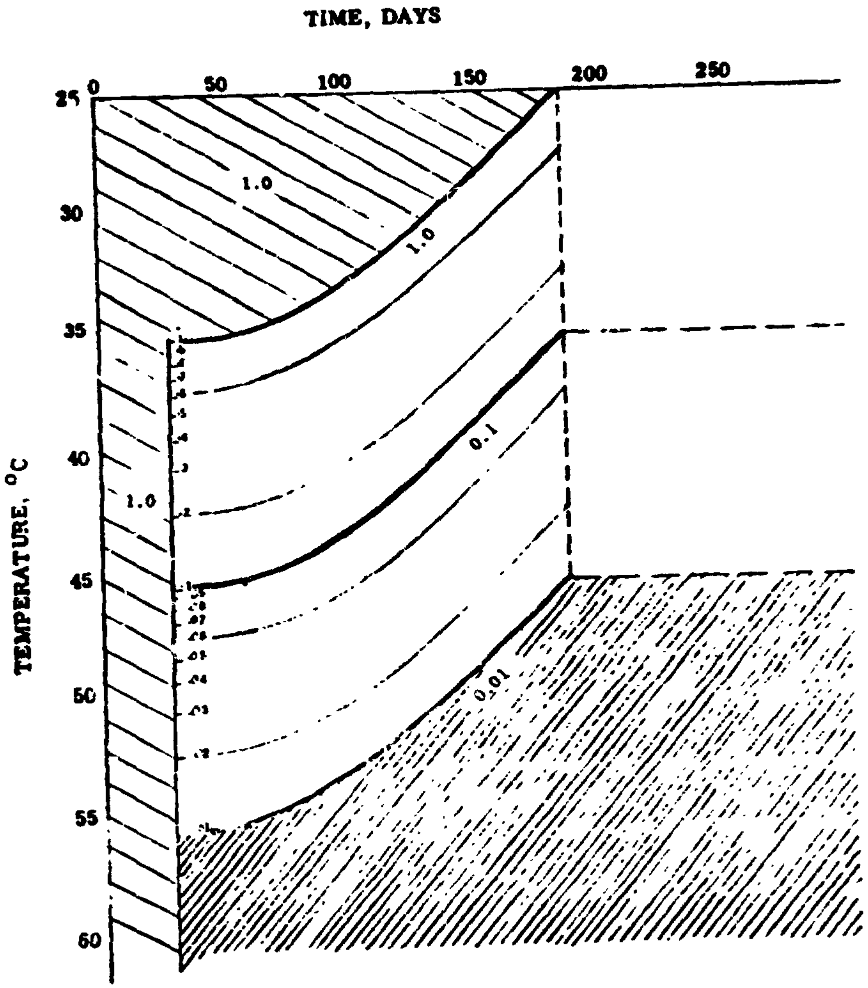


Figure 3.1-13. Proposed P (st) Parameter

ANALYTICAL REVIEW OF DATA
FROM EARLY TEFLON STRIP EXPERIMENTS

Presentation

to

P Q A P

Cape Kennedy, Florida

April 26, 1973

Exotech Systems, Inc.

Pericles D. Stabekis

Early Teflon Strip Experiment Analysis

Summary

At the request of the PQO, an analytical review of data from early teflon strip experiments, using wild organisms, was undertaken and the results and recommendations presented to PQP on April 26, 1973 at Cape Kennedy, Florida. This report summarizes results of this activity.

Discussion

Data resulting from teflon strip experiments conducted at JPL and Cape Kennedy with wild organisms were reviewed and analyzed in an effort to develop a valid method·'ogy to identify the fraction of the surviving sub-population and its heat resistance.

The experiments at JPL were conducted at 125° C; the Cape experiments included tests at both 125° C and 113° C temperatures.

In the course of the analysis, it was recognized that the initial spore population consisted of several sub-populations of varying heat resistance. It became the purpose of the review to identify the most hardy sub-population.

The available data from JPL and the preliminary data from the Cape work were first treated similarly to arrive at an average initial spore population (N_o) and to estimate the most probable number (MPN) of survivors for each run. These data were then plotted versus heating time. In all instances the final two data points were used to derive D values.

The use of only the final two data points (instead of a "best fit" line through all data points) assures a D value representative of the most heat resistant sub-population. In addition, the last two data points are the most valid statistically since the error associated with their determination through the MPN technique is minimal when compared with earlier data points having relatively high MPN's.

Following this procedure, D values were established for the most heat resistant sub-popula 'ons and, through extrapolation, an N_o corresponding to that sub-population was derived. Through this procedure, shown in the following graphs and summary tables, the fraction of the initial spore load representing the most resistant sub-population was obtained.

It is significant to note the consistency observed in all of the data, and the fact that it appears from these results that the Z value of 21°C holds for the wild organisms. It is recognized, however, that the analysis is based on preliminary and, in the case of 113°C experiments, incomplete data. Hence, recommendations were made for additional data particularly in the region where the fraction of survivors is low.

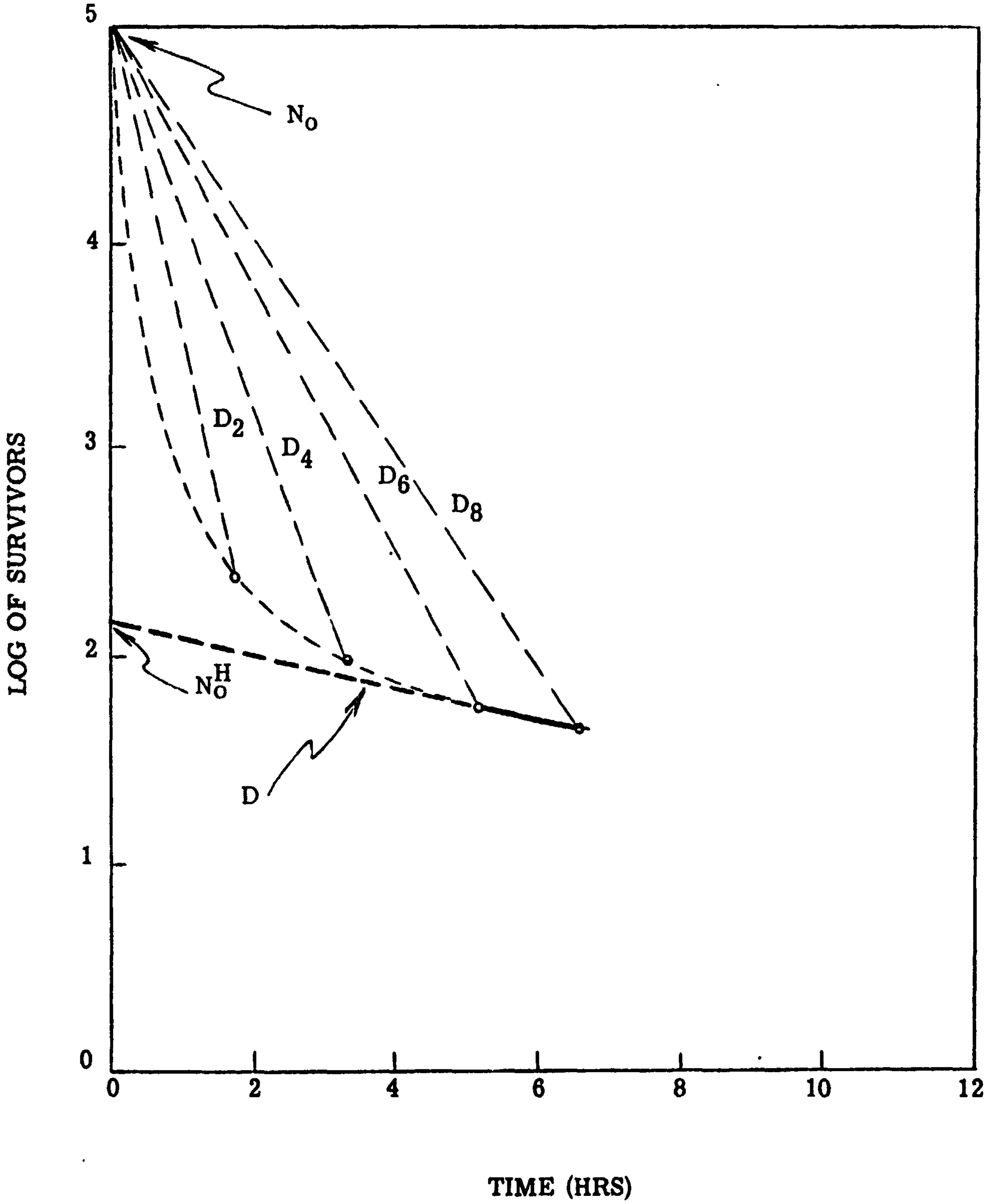
A further recommendation relates to the characterization of survivors which, it is felt, should be taken into account in any reevaluation of P(g).

The following figures, descriptive of the above analysis, were presented to PQP at Cape Kennedy on April 26, 1973.

PURPOSE

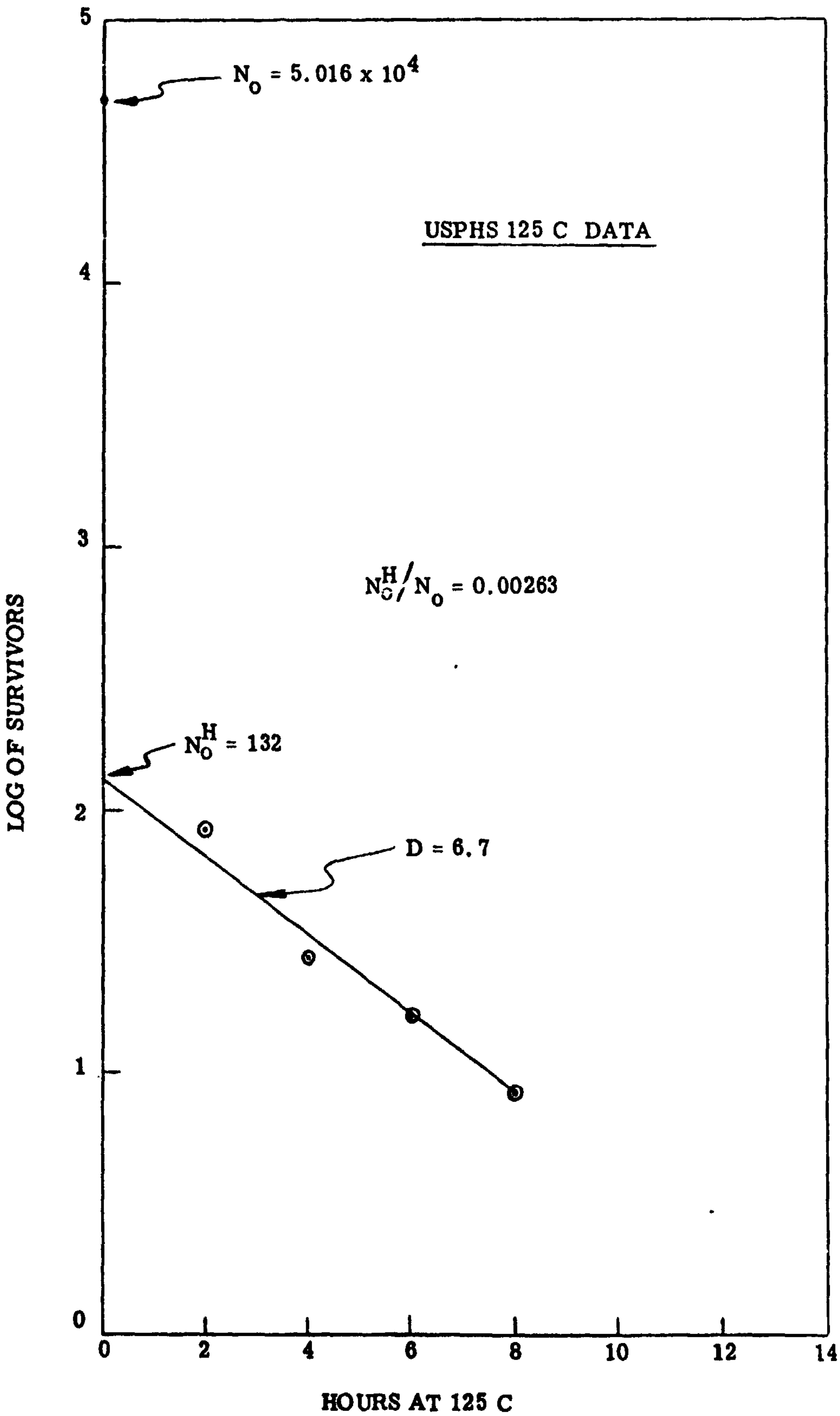
- ESTABLISH COMMON FRAMEWORK FOR EXAMINING THE DATA
- IDENTIFY HEAT RESISTANCE OF THE HARDY SUBPOPULATION
- IDENTIFY THE FRACTION OF THE HARDY SUBPOPULATION TO TOTAL SPORE POPULATION

- APPROACH
- USPHS 125 C DATA
- JPL — WARDLE 125 C DATA
- USPHS EARLY 113 C DATA
- SUMMARY
- CONCLUSIONS
- RECOMMENDATIONS


5
4
3
2
1
0
0
2
4
6
8
10
12
N_o
D_2
D_4
D_6
D_8
N_o^H
D
LOG OF SURVIVORS
TIME (HRS)

USPHS 125 C DATA

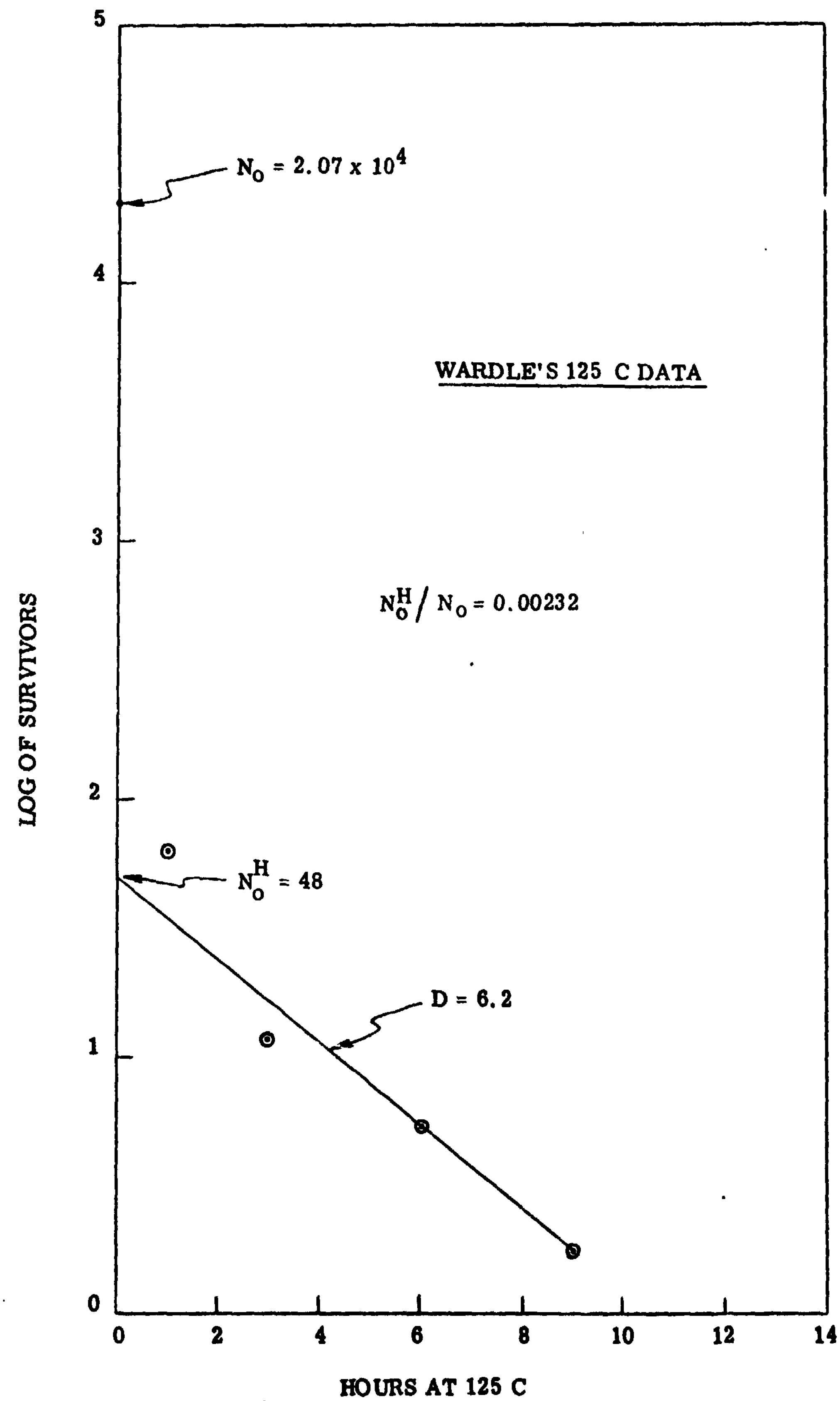
Heating Time (HRS)	No. of Strips	Spores/Strip	Surv. /Strip	Fraction of Positives	MPN/Strip	Total MPN	Average N_o	Total N_o
2	228	2.2×10^2	69/228	.303	.360	82	2.2×10^2	5.016×10^4
4	228	2.2×10^2	26/228	.114	.121	27.6	2.2×10^2	5.016×10^4
6	222	2.2×10^2	16/222	.072	.074	16.87	2.2×10^2	5.016×10^4
8	198	2.3×10^2	7/198	.035	.036	8.21	2.2×10^2	5.016×10^4
9	24	2.0×10^2	---	--	--	---	---	---



USPHS 125 C DATA
$N_o = 5.016 \times 10^4$
$N_o^H / N_o = 0.00263$
$N_o^H = 132$
D = 6.7
LOG OF SURVIVORS
5
4
3
2
1
0
0
2
4
6
8
10
12
14
HOURS AT 125 C

WARDLE'S 125 C DATA

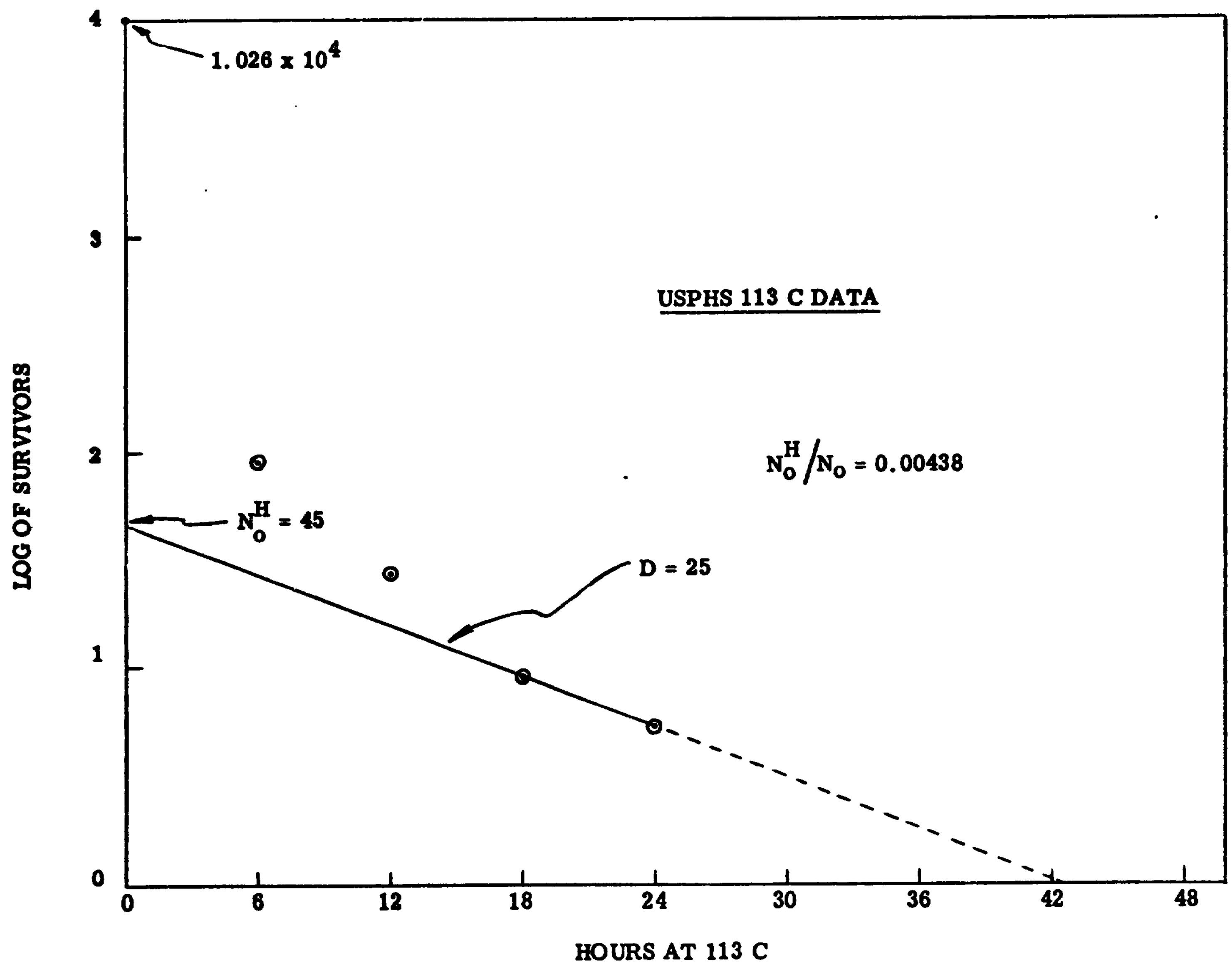
Heating Time (HRS)	No. of Strips	Spores/Strip	Surv. /Strip	Fraction of Positives	MPN/Strip	Total MPN	Average N_o	Total N_o
1	12	5.86×10^2	10/12	0.83	1 79	63	8.65×10^2	2.07×10^4
3	24	1.29×10^3	12/24	0.50	0.693	11.16	8.65×10^2	2.07×10^4
6	23	9.56×10^2	5/23	0.217	0.247	5.35	8.65×10^2	2.07×10^4
9	19	6.29×10^2	1/19	0.0526	0.053	1.75	8.65×10^2	2.07×10^4
13	42	8.33×10^2	0/42	--	--	--	---	---



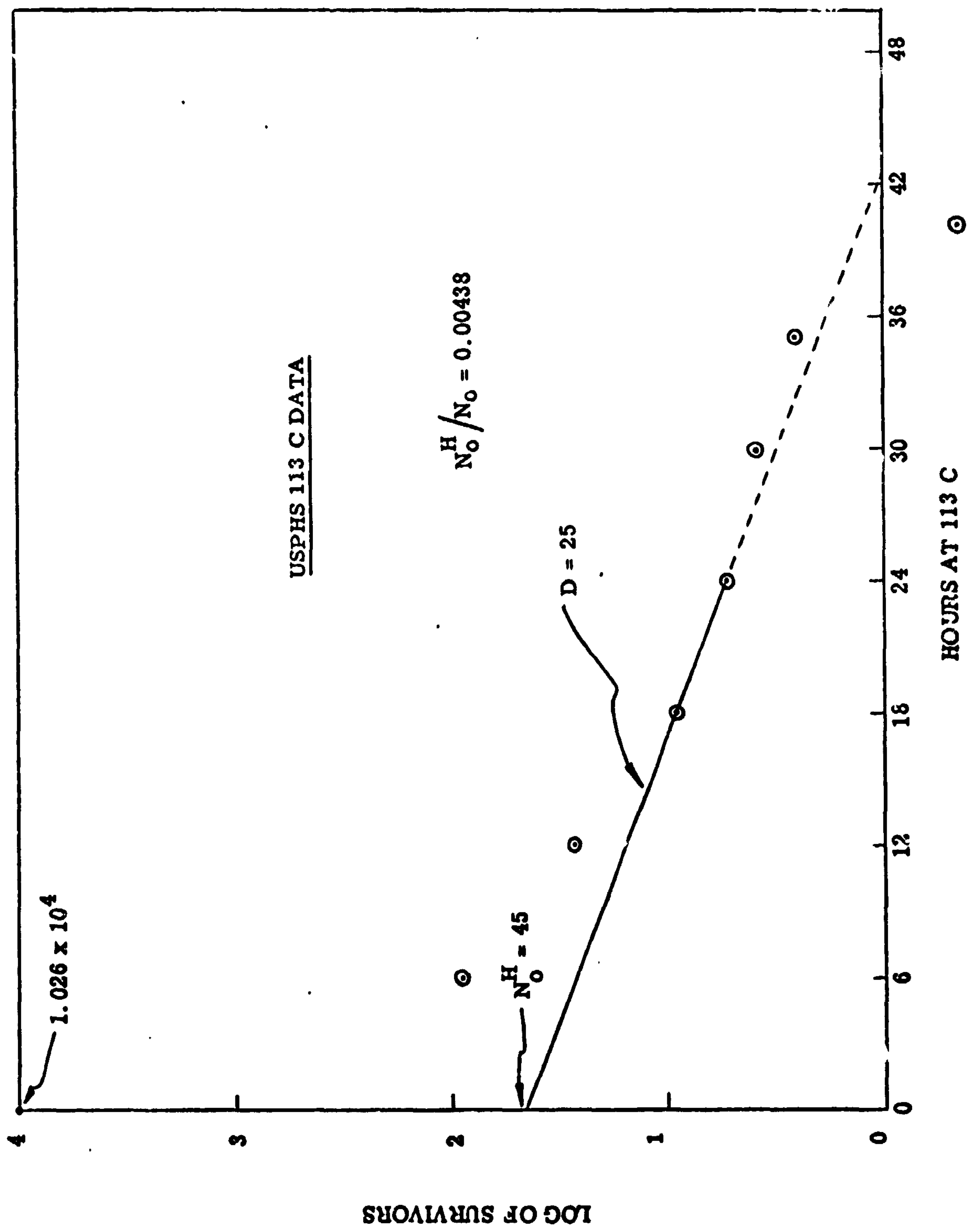
WARDLE'S 125 C DATA
$N_O = 2.07 \times 10^4$
$N_O^H / N_O = 0.00232$
$N_O^H = 48$
D = 6.2
LOG OF SURVIVORS
HOURS AT 125 C
0
1
2
3
4
5
0
2
4
6
8
10
12
14

USPHS 113 C DATA

Heating Time (HRS)	No. of Strips	Spores/Strip	Surv./Strip	Fraction of Positives	MPN/Strip	Total MPN	Average N_o	Total N_o
6	36	3.3×10^2	33/36	.917	2.485	89.46	2.85×10^2	1.026×10^4
12	36	2.6×10^2	19/36	.528	0.750	27	2.85×10^2	1.026×10^4
18	36	3.1×10^2	8/36	.222	0.250	9	2.85×10^2	1.026×10^4
24	36	2.4×10^2	5/36	.139	0.149	5,36	2.85×10^2	1.026×10^4


USPHS 113 C DATA
1.026 x 10^4
N_o^H = 45
N_o^H/N_o = 0.00438
D = 25
LOG OF SURVIVORS
HOURS AT 113 C
0
1
2
3
4
0
6
12
18
24
30
36
42
48

ITEM \ Experimenter	WARDLE (125 C)	USPHS (125 C)	USPHS (113 C)	USPHS (113 C) EXTRAP. TO (125 C)
N_o TOTAL	2.07×10^4	5.016×10^4	1.026×10^4	
N_o^{Hardy}	48	132	45	
FRACTION OF HARDY	.00232	.00263	.00438	
D_{Hardy} (Hours)	6.2	6.7	25.0	6.7



USPHS 113 C DATA
$N_o^H / N_o = 0.00438$
D = 25
$N_o^H = 45$
1.026×10^4
HOURS AT 113 C
0
6
12
18
24
30
36
42
48
LOG OF SURVIVORS
0
1
2
3
4

CONCLUSIONS

- A METHODOLOGY HAS BEEN ESTABLISHED TO IDENTIFY THE FRACTION OF THE HARDY SUB-POPULATION AND ITS HEAT RESISTANCE.
- APPLYING THIS METHODOLOGY, THE DATA ANALYZED APPEARS TO BE CONSISTENT.

RECOMMENDATIONS

- ANY ADDITIONAL DATA SHOULD BE OBTAINED IN THE REGION WHERE THE FRACTION OF CONTAMINATED REPLICATES IS LOW (i.e. < 0.1)

- USING THIS METHODOLOGY AND ANY ADDED DATA, THERE SHOULD BE AN EVALUATION OF THE MANNER IN WHICH THE DATA CAN BE USED TO ASSESS STERILIZATION CYCLES BY FLIGHT PROJECTS

- TO THE EXTENT THE HEAT CYCLE IS BASED ON A RESIDUAL NUMBER OF HARDY ORGANISMS, ANY REEVALUATION OF THE PROBABILITY OF GROWTH, P(g), SHOULD TAKE THIS INTO ACCOUNT

PRESENTATION

To

PLANETARY QUARANTINE PANEL

Denver, Colorado

July 12, 1973

IMPLICATIONS OF NEW INFORMATION ON STERILIZATION REQUIREMENTS

by

Samuel Schalkowsky

EXOTECH SYSTEMS, INC.

SUBJECT:	EFFECT OF PRELIMINARY WILD ORGANISM DATA AND OTHER NEW INFORMATION ON STERILIZATION REQUIREMENTS.
OBJECTIVE:	TO ASSESS POSSIBLE AREAS OF ACTIVITY REQUIRED TO INCORPORATE RELEVANT NEW INFORMATION.
APPROACH:	SYSTEMATIC LOOK AT WHAT PRESENT REQUIREMENTS ARE AFFECTED, AND HOW.

BACKGROUND

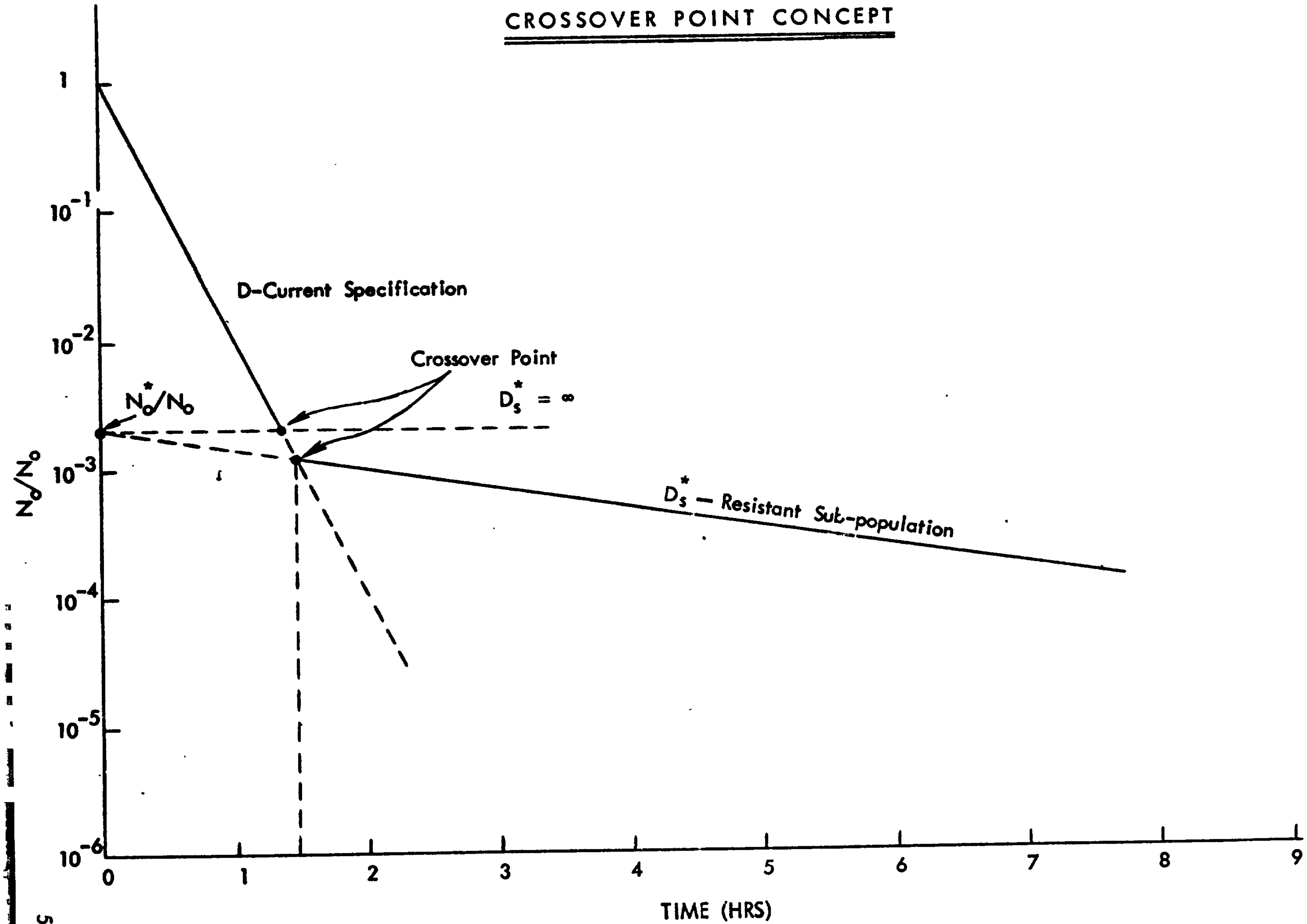
- HEAT RESISTANCE TESTS OF NATURALLY OCCURRING MICROORGANISMS SHOW A HIGHLY RESISTANT SUB-POPULATION

- CURRENT REQUIREMENTS ALLOW FOR RELEASE OF LIMITED NUMBER OF VIABLE ORGANISMS ON PLANET SURFACE

SURVEY OF SPECIFICATIONS

ITEM	APPLICABLE DOCUMENT	PRESENT SPECIFICATION	NEW DATA
Resistance of Surface Microorganisms D_s, Z_s	NHB 8020.12 Para. 2.2.4.2	$D_S^{125^\circ} = 0.5$ hrs $Z = 21^\circ C$ Based on B. Subtilis Data	$D_S^{125^\circ} = 6.5$ (preliminary) for most resistant 0.25% sub-population, $Z = 21^\circ C$
Resistance of Mated Microorganisms D_M, Z_M	NHB 8020.12 Para. 2.2.4.2	$D_M^{125^\circ} = 1.0$ hrs $Z = 21^\circ C$ Based on B. Subtilis Data	Presence of resistant sub-population In "naturally occurring environments"
Resistance of Buried Microorganisms D_B, Z_B	NHB 8020.12 Para. 2.2.4.2	$D_B^{125^\circ} = 5.0$ hrs $Z = 21^\circ C$ Based on B. Subtilis Data	Presence of resistant sub-population in "naturally occurring environments"
Microbial Density in Materials $\bar{d}_v$	Parameter Specification Sheet	130 Spores/cm^3	Presence of resistant sub-population in "naturally occurring environments"
Probability of Microbial Proliferation on Mars $P(g)$	Parameter Specification Sheet	$P(g) = 10^{-6}$ Based on Woods Hole evaluation in July 1970	Survivors are of one type? (Resistant sub-population) New analytical approach (SRI) ? Mariner 9 data.
Counting	NHB 8020.12 Para. 2.2.4.4	Primarily considering Aerobes	Resistant sub-population characteristics
Probability of Surviving Transit Environments P_{st}, P_{uv}, P_{vt}	Parameter Specification Sheet	See Specification Sheets	No new applicable data.
Probability of Release Parameters	Parameter Specification Sheets	See Specification Sheets	No new applicable data

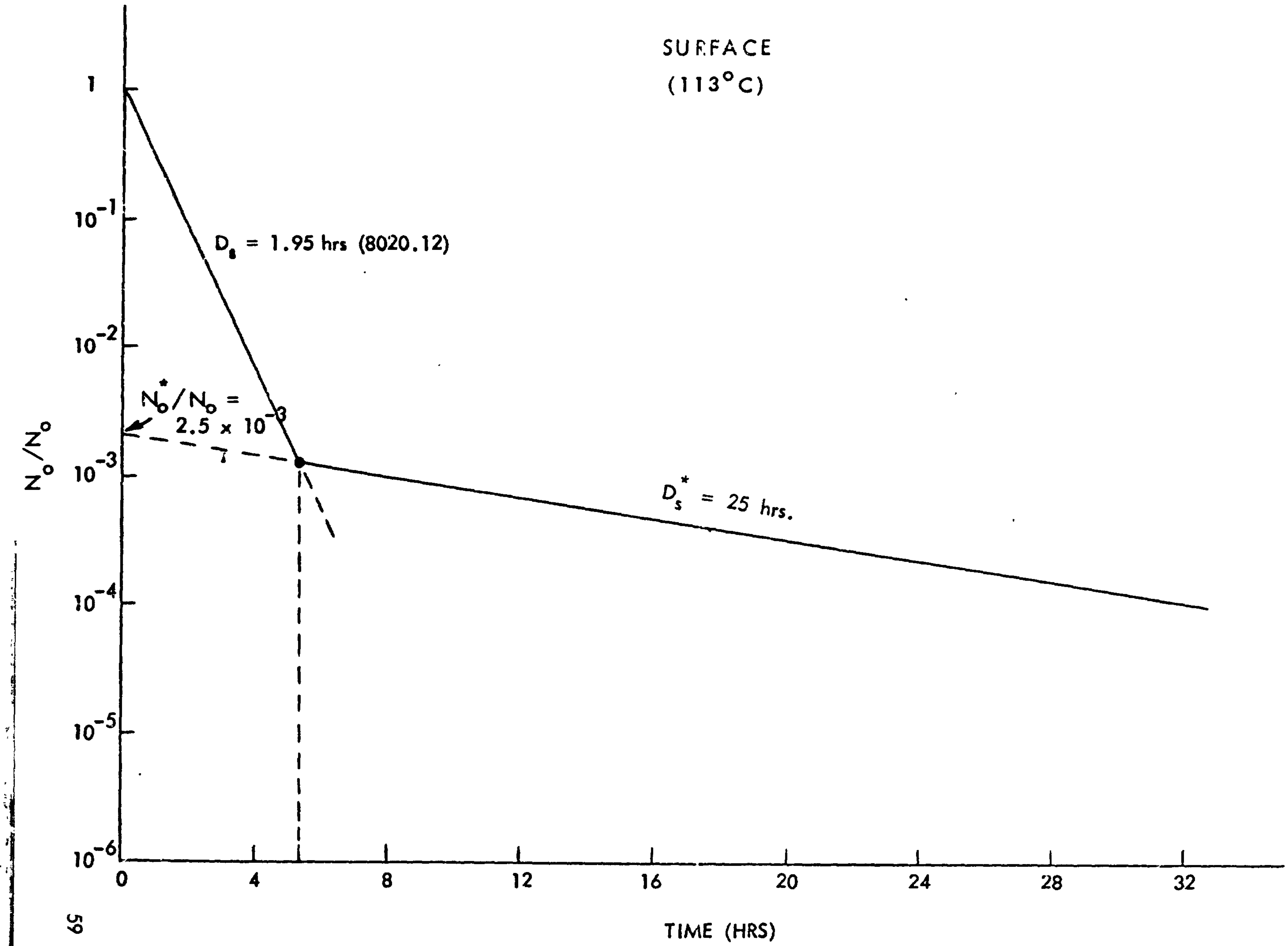
CROSSOVER POINT CONCEPT



CROSSOVER POINT CONCEPT

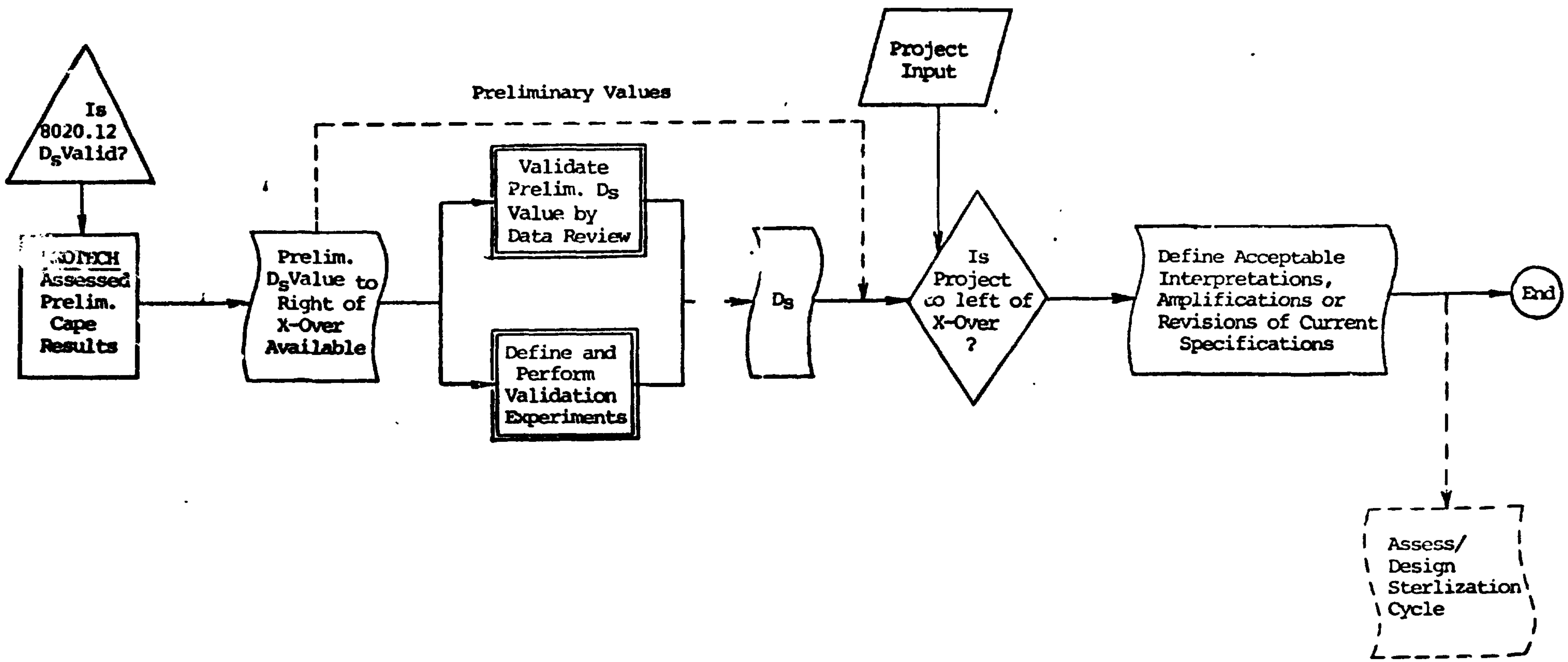
CROSSOVER POINT DEFINED BY ASSOCIATED NUMBER OF DECADES REDUCTION OR BY TIME AT TEMPERATURE DURING STERILIZATION CYCLE.

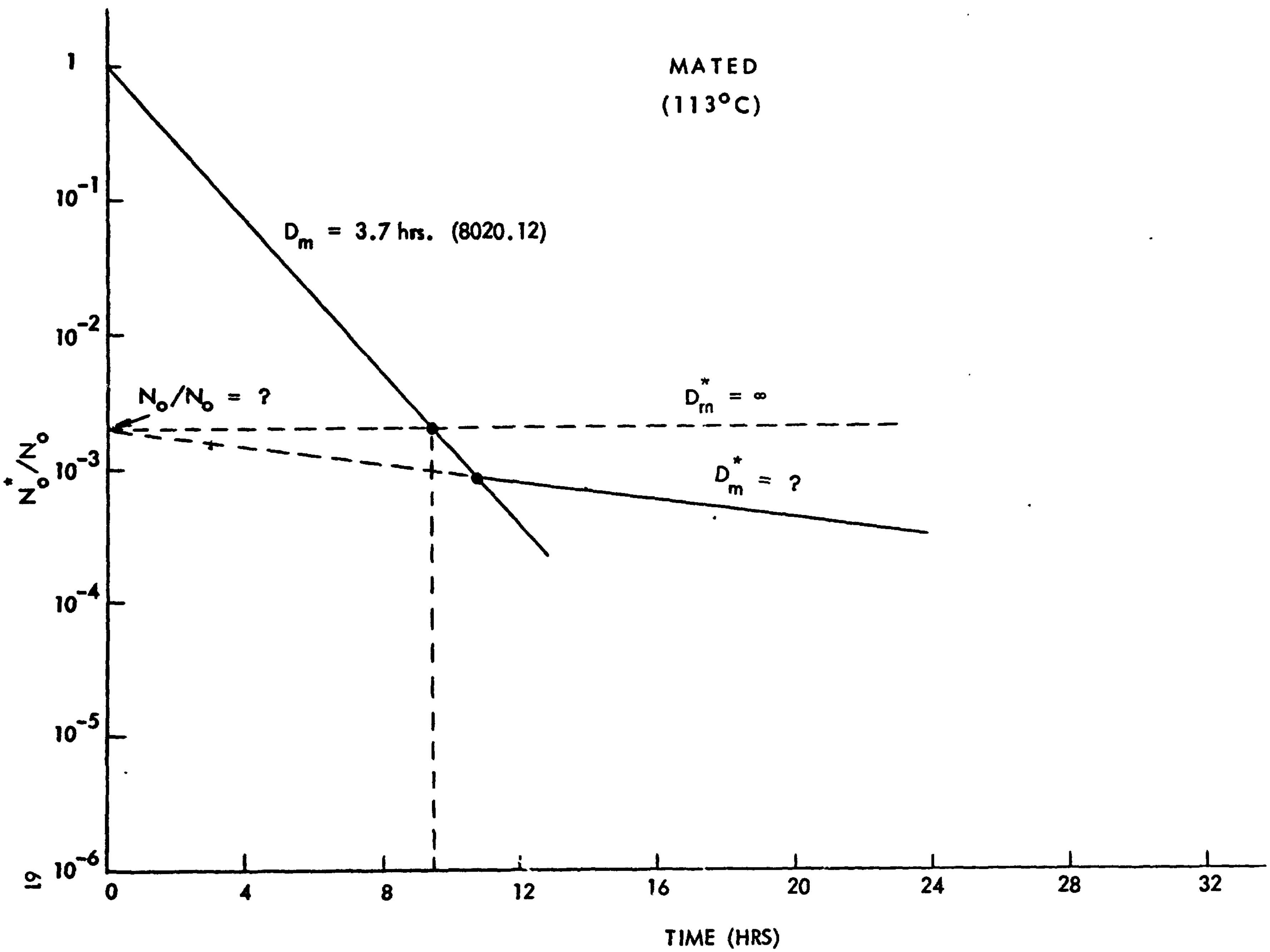
- IF STERILIZATION CYCLE IS TO LEFT OF CROSSOVER POINT, CURRENT NHB 8020.12 REQUIREMENTS ARE CONSERVATIVELY MET.
- IF STERILIZATION CYCLE IS TO RIGHT OF CROSSOVER POINT, CURRENT REQUIREMENTS NEED TO BE REVIEWED.



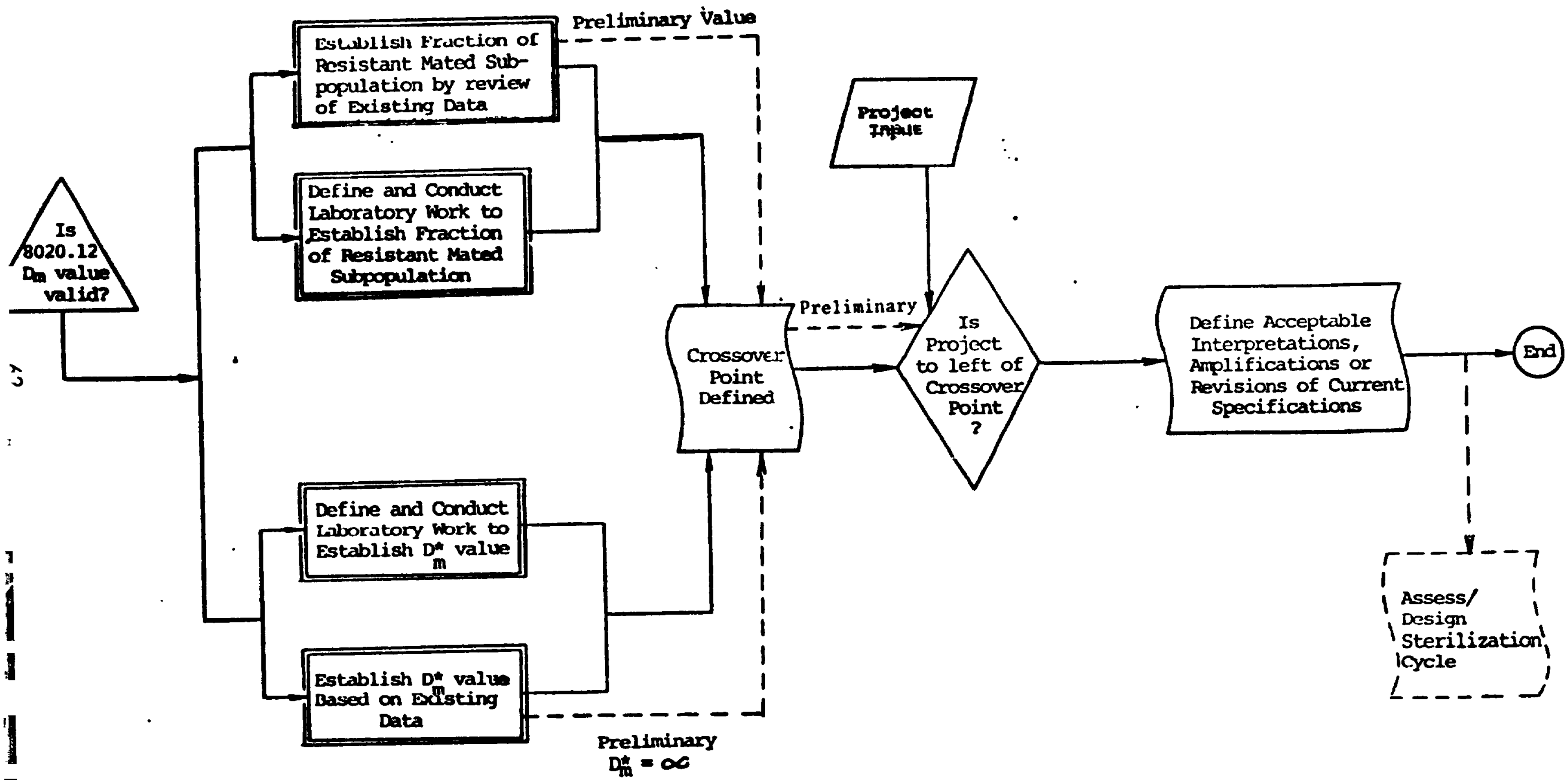
SURFACE
(113°C)
D_s = 1.95 hrs (8020.12)
N_o^*/N_o = 2.5 x 10^{-3}
D_s^* = 25 hrs.
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
N_o/N_o
0
4
8
12
16
20
24
28
32
TIME (HRS)

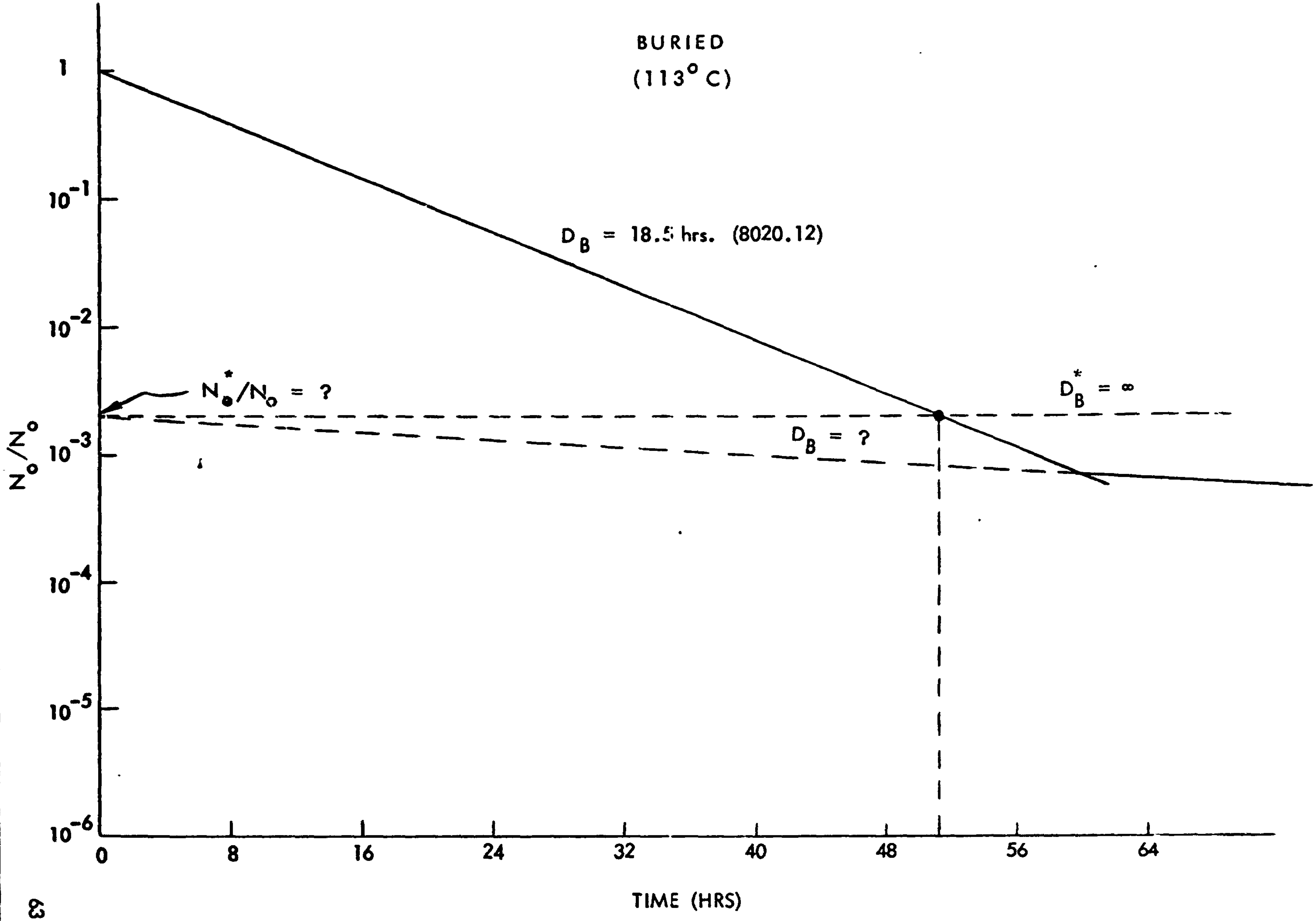
D_s - Surface Heat Resistance




MATED
(113°C)
D_m = 3.7 hrs. (8020.12)
N_o/N_o = ?
D_m^* = ∞
D_m^* = ?
N_o^*/N_o
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
0
4
8
12
16
20
24
28
32
TIME (HRS)

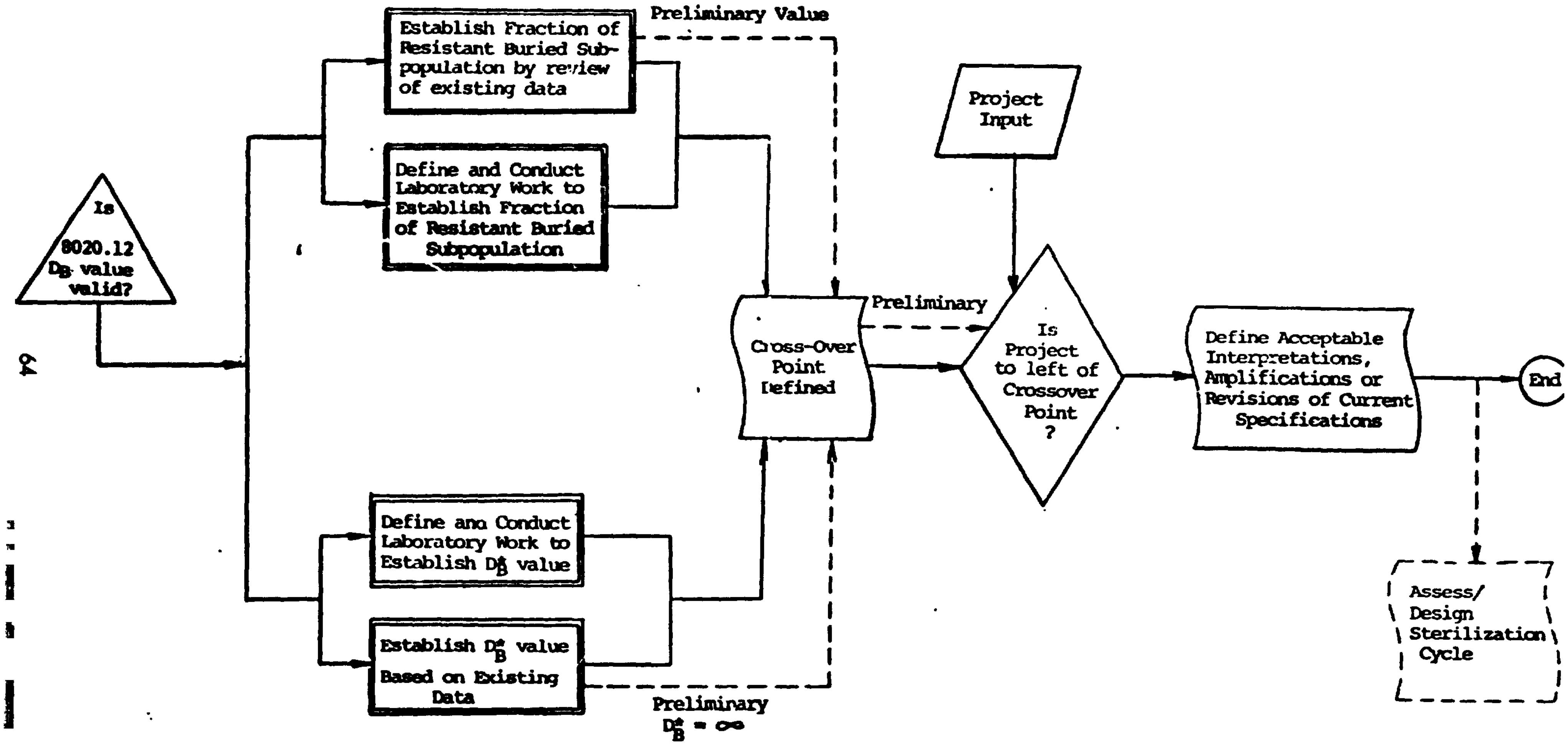
D_m - Mated Heat Resistance





BURIED
(113° C)
D_B = 18.5 hrs. (8020.12)
N*/N_o = ?
D*_B = ∞
D_B = ?
N_o/N_o
1
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
0
8
16
24
32
40
48
56
64
TIME (HRS)

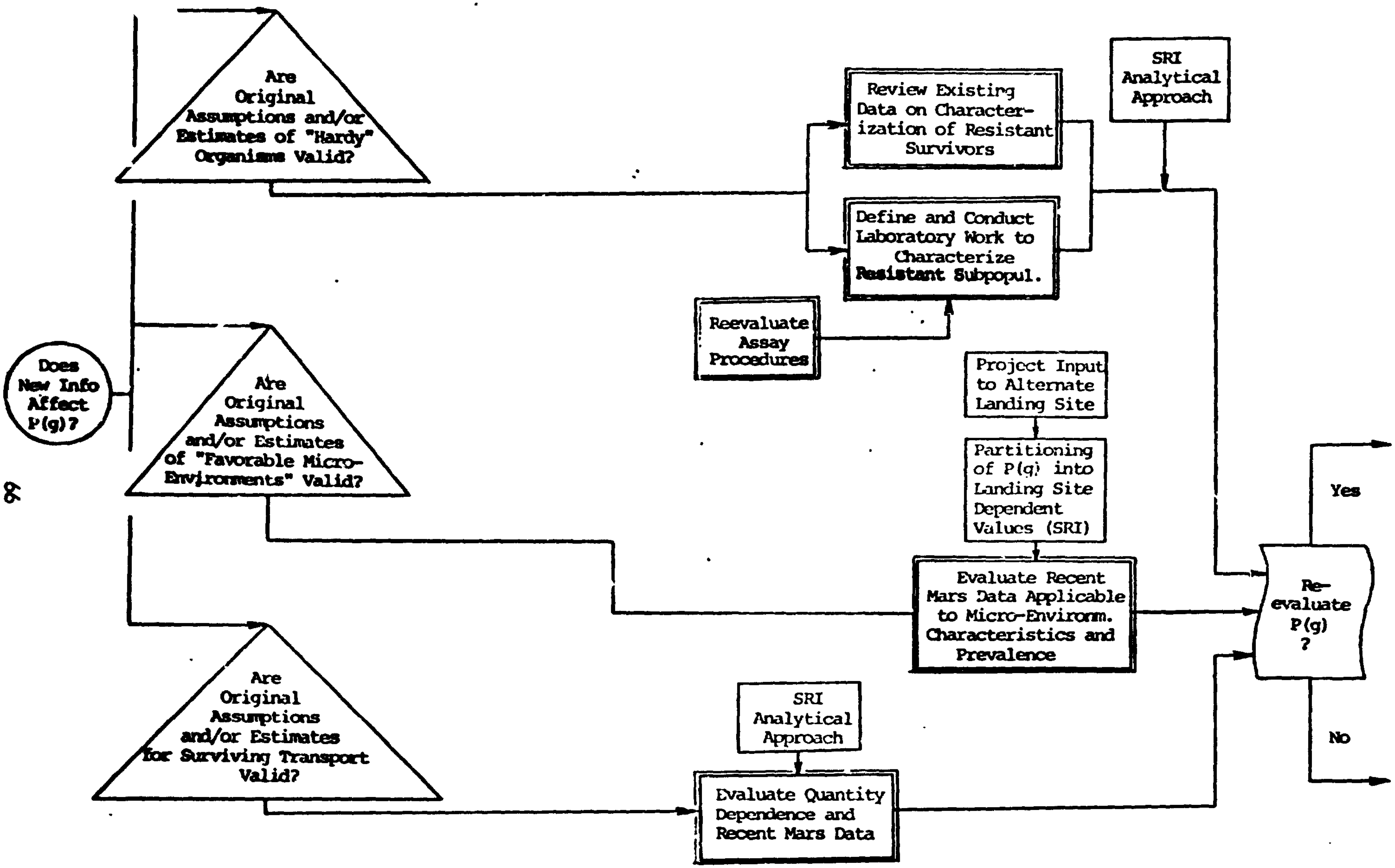
D_B- Buried Heat Resistance



LANDER P(g)

	P (AREOPHILES)	P (HOSPITABLE MICROENVIRONMENT)	P (VIABLE TRANSPORT IN ADEQUATE N'JMBERS)	P (g)
CURRENT VALUES	3×10^{-4} — 10^{-2} (6.3×10^{-3})	10^{-2} — 1 (6.3×10^{-2})	10^{-3} — 10^{-2} (2.5×10^{-3})	3×10^{-9} to 10^{-4} (10^{-6})
NEW INFORMATION	— SURVIVORS COME FROM A SMALL SUB-POPULATION	— PARTITIONING OF P(g) INTO LANDING SITE DEPENDENT VALUES (SRI) — LANDING SITE CONSIDERATIONS — MARINER 9 DATA	— NUMBER OF SURVIVORS SMALL — MARINER 9 DATA	?

LANDER P(g)



Does New Info Affect P(g)?
Are Original Assumptions and/or Estimates of "Hardy" Organisms Valid?
Review Existing Data on Characterization of Resistant Survivors
Define and Conduct Laboratory Work to Characterize Resistant Subpopul.
SRI Analytical Approach
Reevaluate Assay Procedures
Are Original Assumptions and/or Estimates of "Favorable Micro-Environments" Valid?
Project Input to Alternate Landing Site
Partitioning of P(g) into Landing Site Dependent Values (SRI)
Evaluate Recent Mars Data Applicable to Micro-Environm. Characteristics and Prevalence
Are Original Assumptions and/or Estimates for Surviving Transport Valid?
SRI Analytical Approach
Evaluate Quantity Dependence and Recent Mars Data
Re-evaluate P(g) ?
Yes
No

IMMEDIATE CONSIDERATIONS

1. D_s^*, $[N_o^*/N_o]_s$

   Are preliminary values derived by Exotech usable?

   (D_s^* = 25 hrs @ 113° C, $[N_o^*/N_o]_s$ = 2.5×10^{-3})

2. $[N_o^*/N_o]_m$

   What is an acceptable preliminary value?

   Is the same value as for surfaces reasonable?

3. $[N_o^*/N_o]_b$

   What is an acceptable preliminary value?

   Is the same value as for surfaces reasonable?

4. Lander P(g)

   Are there sufficient new inputs (see chart) to justify a re-evaluation of P(g) for landers?

APPENDIX B

- Technical Information Memo
  Volume 2, Number 1
  Volume 2, Number 2

PLANETARY QUARANTINE
TECHNICAL INFORMATION MEMO

Volume 2, Number 1 July 6, 1973

Issued by Exotech Systems, Inc., 5205 Leesburg Pike, Falls Church, Virginia 22041, by direction of NASA's Planetary Quarantine Officer.

ANNUAL COSPAR MEETING

The 1973 Meeting of the COSPAR Working Group 5 was held May 29 through June 2 at Konstanz, FRG. Ten (10) papers were presented at the meeting of Panel D, Planetary Quarantine:

- L.7.1 Ten Years of Development of the Planetary Quarantine Program of the United States, by L.B. Hall.
- L.7.2 Verification of the Efficacy of Spacecraft Sterilization, by V.I. Vashkov, N.V. Ramkova, G.V. Shcheglova, et al.
- L.7.3 The Viking Project Planetary Quarantine Considerations, by L.P. Daspit.
- L.7.4 Dry Heat Sterilization for Viking Landers, by R.D. Howell.
- L.7.5 Lunar Sample Quarantine Procedures: Interaction with Non-Quarantine Experiments, by M.B. Duke and M.A. Reynolds.
- L.7.6 Lethality of the Space Environment for Microorganisms, by D.M. Taylor, et al.
- L.7.7 Terrestrial Quarantine Considerations for Unmanned Sample Return Missions, by L.W. Miller, W. Stavro, D.M. Taylor and A.R. Hoffman.
- L.7.8 Reduction of Microbial Burden by Heating Due to Spacecraft Entry Into the Jupiter Atmosphere, by C. Gonzalez, W. Jaworski, A. McRonald and A.R. Hoffman.
- L.7.9 Quarantine Constraints as Applied to Satellites, by A.R. Hoffman, W. Stavro, and C. Gonzalez.
- L.7.10 Probability of Growth Analysis for Jupiter, Saturn and Their Satellites, by R.M. Berkman and D.M. Taylor.

The paper by V.I. Vashkov, et al reported that in the USSR, studies are being made of the effectiveness of dry heat, gas and radiation sterilization for PQ purposes. Microbial strains have been selected for this work on the basis of their providing "standard" resistances to given sterilization agents. The paper adds significantly to the information available on PQ work in the USSR.

USSR — USA EXCHANGES PLANNED

Progress toward meaningful collaboration between the United States and the Soviet Union in PQ-related matters was achieved during the COSPAR meetings with an agreement to exchange specimens of test organism cultures. Details of the exchange protocol are now being worked out and the USSR cultures are expected to be available later this summer.

PQ PARAMETER BOOK

A notebook format is being developed for PQ Officer-authorized specification sheets covering the full range of PQ parameters. The objective is to provide an individualized, controlled collection of parameter specification and information sheets for use by Flight Project Personnel and others concerned with PQ standards and compliance measures. Details on the development, distribution and maintenance of these books will be presented at the Seminar in Denver, Colorado on July 11, 1973. TIM recipients not attending the seminar will receive full information about the book in a letter from Dr. Hall in the near future. Dr. Hall's letter on this subject will advise all interested parties on how to obtain a copy of the book.

STOCKHOLM SYMPOSIUM

Dr. C.-G. Heden was instrumental in arranging a conference, early in June, on automated methods in bacteriology. Dr. J.E. Campbell of the Cincinnati Research Laboratories described a device, now in prototype stage, for rapid counting of colonies. Dr. D. [illegible]er, Nobel Laureate, described equipment employing computer-coupled cameras to identify human pathogens. The initial stages of the work leading to this development were sponsored by the PQ Program. Dr. Paxton Cady presented a paper describing a method of microbial taxonomy using measurements of electrical resistance of culture media. A high specificity is claimed for this technique, with 75 strains identified. Antibiotic agents were used to challenge suspect growth.

USPHS WITHDRAWS PQ SUPPORT

As a result of a 32% reduction in force at the Center for Disease Control, Atlanta, Georgia, the USPHS has announced that it will withdraw its support of the Planetary Quarantine Program. This action affects operations and personnel at the Cape Kennedy Bioassay Laboratory, the Phoenix Laboratories and NASA/Headquarters staff. Alternatives for sponsorship of the affected personnel are being actively pursued. The CDC has agreed to a continuation of Dr. Favero's contribution on a limited basis. It is fully anticipated that employment of the other staff members will be sustained through another organization before the CDC cut off date of September 14, 1973.

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PAPERS INVITED

Dr. Carl Sagan, as editor of ICARUS, has extended an invitation via Larry Hall for all participants in PQ-related research to consider that journal as a possible vehicle for publication of papers. Particular interest was expressed for papers concerned with the growth of microorganisms on planetary surfaces and atmospheres.

DR. BREWER IS BACK

We are very pleased to be able to report that Dr. Brewer has made good progress in recovering from injuries sustained in his motorcycle accident. He met with other members of the PQ Panel at Cape Kennedy in April and is expected to attend the upcoming Seminar in Denver.

MEETINGS

AIBS Seminar	Denver, Colorado	July 11 - 12, 1973
Planetary Quarantine Panel	Denver, Colorado	July 13, 1973

PLANETARY QUARANTINE
TECHNICAL INFORMATION MEMO

Volume 2, Number 2 August 23, 1973

Issued by Exotech Systems, Inc., 5205 Leesburg Pike, Falls Church, Virginia 22041, by direction of NASA's Planetary Quarantine Officer.

JPL ASSIGNED MAJOR PQ ROLE

The Jet Propulsion Laboratory (JPL) has been assigned the project office role for Planetary Quarantine. The procurement and monitoring of most of the research undertaken by the Planetary Quarantine Program, including the operation of the biological laboratory at KSC, will be the responsibility of JPL. Dr. Charles Craven will serve as JPL's project manager and will direct all related work.

USSR LAUNCHES MARS SPACECRAFT

The USSR took advantage of the 1973 Mars window to launch four spacecraft, Mars 4, 5, 6 and 7. It is expected that their mission includes orbiting the planet, making Mariner 9-type observations. There is considerable speculation on the possibility of a surface probe and a soft landing. These flights continue the tradition of strong Soviet commitment to planetary exploration. Since such exploration started, the USSR has taken virtually every opportunity to launch probes to Mars and Venus.

EXTINCTION IN LOW HUMIDITY TESTS

Recent heat inactivation tests at extremely low water levels conducted by Rudy Puleo's group on naturally occurring contamination collected by fall out on teflon strips at KSC are showing microbial extinction in most cases. These tests tend to substantiate, with naturally occurring microorganisms, the effect established in the laboratory by Pflug, Angelotti, Campbell and others with subcultures. The recent tests were run at 113° C with less than 0.01 mg/liter of water for the duration of the planned Viking Lander capsule sterilization cycle.

US – USSR MICROORGANISM EXCHANGE

The planned exchange of microorganism colonies [TIM: Vol. 2, No. 1, July 1973] has been advanced by the recent shipment by the US of a wide variety of strains including the "super" spore. Unfortunately, the reciprocal shipment has been delayed because of US import controls but completion of arrangements is expected in the next few weeks.

ODORLESS FORMALDEHYDE DEVELOPED BY SANDIA

Three new formaldehyde disinfectants that do not emit the irritating odor and vapor of regular formaldehyde have been announced by Sandia Laboratories. These newly-developed compounds should be useful in a number of hospital and household applications where regular formaldehyde is objectionable despite its bacteriacidal effectiveness. NASA has filed for a patent on the new disinfectants which were developed by Ralph E. Trujillo and Kermit F. Lindell during PQ research.

LSC MEETINGS AT TRW

Two subcommittees of the NASA Life Sciences Committee met at TRW in Los Angeles on August 21 and 22 to review the Viking biology experiment package. The PQO and members of the project PQ group attended.

PERSONALIA

Dr. Jerry J. Tulis presented a paper at the recent Stockholm Symposium on Rapid Methods and Automation in Microbiology. Drs. Hall and Campbell attended the meeting.

Dr. John Brewer will spend much of August at the University of Minnesota coordinating experimental aspects of the work of Hardin-Simmons on the heat resistance of psychrophilic microorganisms.

Dr. G. Briggs Phillips reports that Dr. W.S. Miller of the Becton, Dickinson Research Center has been appointed to the American Academy for Microbiology.

Dr. Richard Green has been appointed Deputy Manager, Biomedical Systems, in the JPL Civil Systems Project Office.

Marv Christensen is also working in the JPL Civil Systems Project Office. He is the Task Manager on the Student Advisory Resource System in the Public Safety Systems group and interfaces with the State of California Department of Education.

Dr. Martin S. Favero reported to the AIBS Seminar in Denver on the very significant work that he and his colleagues have been undertaking in contamination control in identifying and reducing microbiological hazards associated with artificial kidney machines.

Dr. L.B. Hall plans to be vacationing in Georgia and Florida during the first two weeks of September.

Dr. Roy Cameron, well known in planetary quarantine activities for his work on the microbiology of the dry valleys of Antartica, is now Director of the Charles Darwin Research Institute; 24703 Dana Drive, Dana Harbor; Dana Point, California 92629.